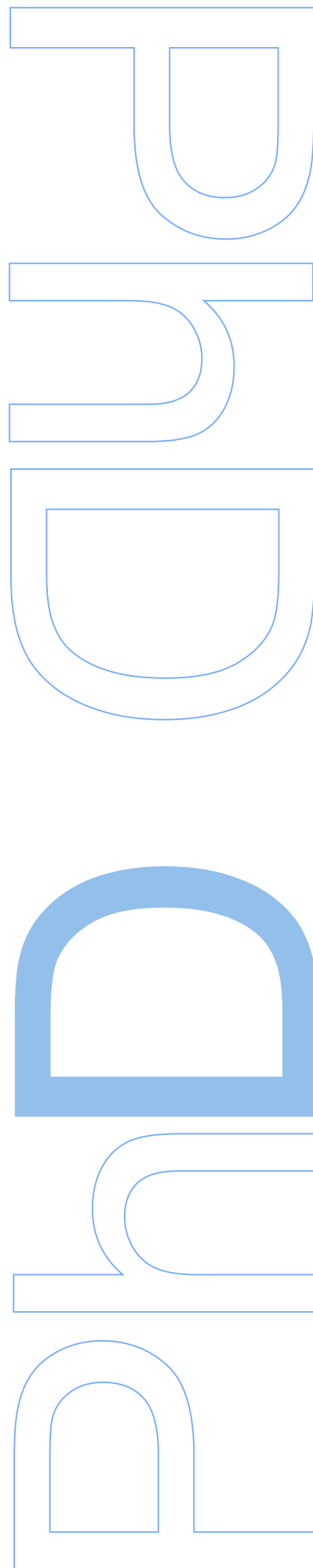


Health Communication: A New Model to Promote Cancer Prevention Campaigns at Schools

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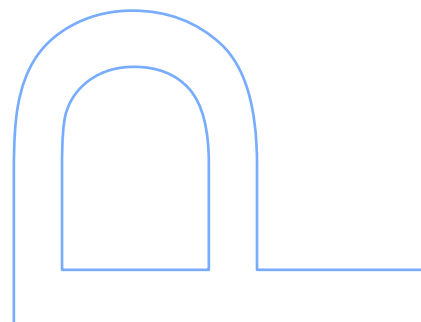
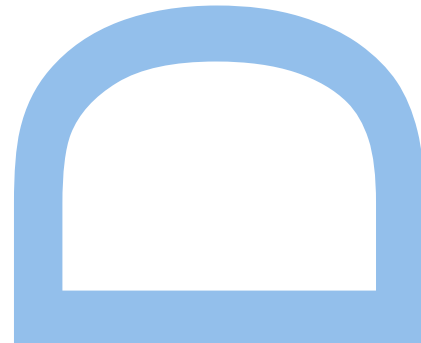
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*We may never understand illnesses such as cancer.
In fact, we may never cure it.
But an ounce of prevention is worth more than a million pounds of cure.*

***David B. Agus
The End of Illness, 2011***

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Abstract

Science occupies a prominent place in knowledge society with a real, although unknown, impact in our lives and societies, especially in today's health and in the health of future generations.

Chronic diseases management is an example of the prodigious science developments in the last decades. However, there are diseases that remain a worldwide challenge for public health policies and programs, such as cancer for which an increase in incidence is estimated for the next decades.

In this perspective, cancer communication has a significant role in what concerns cancer prevention, assumed as the best strategy to effectively reduce cancer burden. Regarding the current epidemiological scenario on cancer, preventive interventions are, consequently, of the utmost importance.

The leading model of health prevention campaigns is based on general and undifferentiated actions mediated by health professionals, focusing on the technical and scientific information and rather ineffective in its changing impact of (symbolic, cognitive and practical) relationship with the disease.

The present research assumes that early interventions, tailored and targeted to specific groups, and monitored, can contribute to positive and durable changes in prevention, specifically regarding cancer prevention. The aim is to understand a reality shaped by the traditional health prevention campaigns that result from the interaction of the current epidemiological, cultural and social scenario about cancer, regarding the potential of the schools as a vehicle for cancer education, as well as to transform that reality (in this case, teachers and students cancer literacy).

A novel approach for cancer prevention education was developed focusing on high-school biology teachers, whom are considered as privileged mediators of the communication process with students (and, indirectly, with families). A training program, "Cancer, Educate to Prevent" was applied, so that the teachers were able to independently develop and implement prevention campaigns focused on students and school-related communities. The program encompassed different educational modules, ranging from cancer biology to prevention campaigns design.

Along with the implementation of the training program, a protocol of systematic surveying was developed to assess the impact on teachers and students cancer literacy, on specific dimensions, perceptions and knowledge about cancer and its prevention.

The results obtained for the students baseline of cancer literacy revealed a medium/low level of cancer literacy, which emphasizes even more that it is necessary to design, target and adapt future campaigns (messages and procedures) that will help to increase cancer literacy and decision-making competences to enable beneficial behavior changes towards cancer prevention.

Regarding the teachers that participated in the training program, they were empowered to develop and implement their own campaigns in a population of up to five thousands students, cancer literacy levels were not so critical, when compared to the students, but with the training they were substantially improved. In addition the cancer literacy levels of the students increased significantly at the end of the implementation of the cancer prevention campaigns.

All along the implementation of the prevention program, the procedures were monitored in the field, i.e., systematically observed and supervised by the operational coordinator (the author of this dissertation). The importance given to the field work is essential to analyze and interpret all the protocols and results.

The successful implementation of the training program highlights the feasibility of cancer prevention programs planned as focused interventions in restricted targets and mediated by non-healthcare professionals.

Bearing in mind that most cancer prevention campaigns in the Western World are based on similar strategies, our results suggest that improving cancer prevention education strategies holds enormous potential in terms of reducing cancer burden of future generations from several countries.

Keywords: Health Communication, Cancer, Prevention, Campaigns, Cancer Literacy, Schools, Teachers, Adolescents.

Resumo

A Ciência ocupa um lugar de destaque na sociedade do conhecimento, com um impacto real, apesar de desconhecido, nas nossas vidas e sociedades, especialmente no que respeita à saúde de hoje e das gerações futuras.

O controlo das doenças crónicas é um exemplo bem sucedido da evolução da ciência nas últimas décadas. No entanto, existem doenças que continuam a constituir um desafio mundial para as políticas e programas públicos de saúde, como é o caso do cancro e, para o qual se estima um aumento da sua incidência nas próximas décadas.

Nesta perspetiva, a comunicação sobre o cancro tem um papel significativo no que diz respeito à sua prevenção, assumindo-se como a melhor estratégia para reduzir efetivamente o ónus associado a esta doença. Em relação ao cenário epidemiológico atual sobre o cancro, as intervenções preventivas são, por conseguinte, da maior importância.

O modelo tradicional das campanhas de prevenção de saúde é baseado em ações gerais e indiferenciadas mediadas por profissionais de saúde, com foco na informação técnica e científica e bastante ineficazes no que respeita ao seu impacto na mudança de relacionamento (simbólica, cognitiva e prática) com a doença.

Nesta investigação assume-se que as intervenções precoces, adaptadas e dirigidas a grupos específicos, e monitorizadas, podem contribuir para mudanças positivas e duradouras no que se refere à prevenção, especificamente em relação à prevenção do cancro. O objetivo é compreender uma realidade moldada pelas tradicionais campanhas de prevenção em saúde que resultam da interação do atual cenário epidemiológico, cultural e social sobre o cancro, em relação ao potencial das escolas como veículo para a educação sobre o cancro, bem como para a transformação dessa realidade (neste caso, da literacia sobre cancro dos professores e dos seus alunos).

Foi desenvolvida uma nova abordagem para a educação para a prevenção do cancro focada nos professores de biologia do ensino secundário, os quais são considerados mediadores privilegiados do processo de comunicação com os alunos (e, indiretamente, com as famílias). A ação de formação "Cancro, Educar para Prevenir" foi aplicada, de modo a que os professores fossem capazes de desenvolver de forma independente e, implementar campanhas de prevenção dirigidas aos alunos e comunidades escolares. O programa abrangeu diferentes módulos de ensino, que vão desde a biologia do cancro ao design de campanhas de prevenção.

Juntamente com a implementação da ação de formação, foi desenvolvido um protocolo de levantamento sistemático capaz de avaliar o impacto desta iniciativa nos níveis de literacia

sobre cancro dos professores e alunos, tendo em conta dimensões específicas, percepções e conhecimentos sobre o cancro e a sua prevenção.

Os resultados obtidos acerca dos níveis de literacia dos alunos revelaram que os alunos se situam num nível médio baixo, no que respeita à literacia sobre cancro. Estes resultados enfatizam a necessidade de repensar, dirigir e adaptar futuras campanhas (mensagens e procedimentos) que ajudarão a melhorar a literacia sobre esta doença, bem como a capacidade de tomada de decisões, permitindo mudanças de comportamento benéficas em relação à prevenção do cancro.

Os professores participantes, foram capacitados para desenvolver e implementar as suas próprias campanhas numa população de cerca de cinco mil alunos, os níveis de literacia dos professores não se revelaram tão críticos, quando comparados com os dos alunos, mas apesar disso, a ação de formação teve um impacto positivo nos níveis de literacia dos professores, tendo estes melhorado substancialmente. Além disso, os níveis de literacia dos alunos aumentou significativamente no final da implementação das campanhas de prevenção concebidas pelos professores.

Esta investigação, permitiu a monitorização no terreno da implementação de todos os procedimentos, isto é, através de uma observação sistemática e supervisionada pela coordenadora operacional (a autora desta dissertação). A importância dada ao trabalho de campo é essencial para analisar e interpretar todos os protocolos e resultados. A implementação bem sucedida do programa de formação destaca a viabilidade de programas de prevenção de cancro planeados como intervenções focadas em alvos restritos e mediadas por profissionais de outras áreas que não a saúde. Tendo em conta que no mundo ocidental, a maioria das campanhas de prevenção do cancro são baseadas em estratégias semelhantes, os resultados desta investigação sugerem que uma melhoria das estratégias de educação para a prevenção do cancro constituem um enorme potencial em termos de redução da incidência nas futuras gerações de vários países.

Palavras-chave: Comunicação em Saúde, Cancro, Prevenção, Campanhas, Literacia em cancro, Escolas, Professores, Adolescentes.

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General Introduction

From Science to Health Communication - The response of scientific community to the development and progress of modern societies

For a long time, science and scientific knowledge were unreachable, even to the literate public, belonging only to those that worked for it. At the time, the producers of scientific knowledge believed that science should only be understood and judge by those that work for it. There was a critical gap between science and the public, even with the literate ones. Despite the scientific content being restricted to those who produced it (because they had the ability or competence to acquire knowledge), the relevance of the "producers of science", do not stood out from other social roles. Science was not an autonomous field and the role of other social structures was dominant towards science (Shapin, 1990).

However, since the emergence of modern science with the scientific revolution in the 17th century that science has an important position in society. Galileo Galilei, one of the most notable figures of this revolution, was also a pioneer in communicating science to the public, bringing closer the two worlds apart. For him it was essential that people understood, not only a scientist work but also the concepts underneath scientific research in order to enrich people's culture towards science (Campbell, 2006).

The scientific revolution was the cornerstone for a deep transformation in the relations between science and public, its communication and dissemination in a broader sense led to the clarification and settlement of science that until then was seen as a dark and mystified field (Shapin, 1990). In fact, as already noted, science gained a specific power in the construction and reinforcement of modernity, and became one of the most powerful institutions in our society. Following Bourdieu (1999), science (allied with technology) became an autonomous field, with its own specialists, its own rules of functioning and reproducing its own power. The power of science relies mostly on maintaining the distance from lay people – through knowledge and language.

The development of modern science, especially when coupled with technology (in 19th and 20th centuries) has led to a reified representation of science, which was seen as an unquestionable guarantee of human progress. As modern science evolves, new concepts of scientific culture and science communication emerge, translating the approach between scientific community and lay people. Many factors contributed to the transformation in the relation between science and the public or society, the most important ones, occurred in the 19th century, with the access of the population to schools and consequently an increase of literacy and the introduction of scientific knowledge into the school curricula. Since then, school has been the main source of scientific knowledge for the public (Wagner, 2007;

Shapin, 1990). On the other hand science specialization, allowed a space for science popularization, that otherwise would be inaccessible to people (Godin & Gingras, 2000; Shapin, 1990). Moreover, in the 20th century, the media, museums or other forms of science representation, had a pivotal role concerning the publics' perceptions not only about science, but also about technology and medicine (Shapin, 1990).

As stated by Shapin (1990:991) "in the past relations between science and the public were intimate, pervasive and consequential", on the contrary, nowadays science is an autonomous field, a social institution with a prominent place in society. Besides its autonomy in which concerns to the control of the scientific proceedings the public interact with the scientific community through distinct channels provided by the field of science communication.

Science Communication - Overview

Science communication appears in order to answer a simple desire: let people know or access the knowledge. However, this idea has been changing throughout the time. Today the problem is not the access to information but the content in itself (relevance and reliability). Communication is essential for the whole process; so today we see a twofold problem. On the one hand the channels of communication and on the other the information content (McKeon, 1957).

Explaining, what is science communication is not a simple task, once it involves a set of other concepts that sometimes are complex, misunderstood or interchangeably used, such as scientific culture, public awareness of science, public understanding of science. Scientific culture and public understanding of science are the most well known concepts, but indeed their definitions are complex and not consensual (Burns, O'Connor and Stocklmayer, 2003). Burns, et al. (2003:191) proposed a contemporary definition for science communication that tries to comprise the complexity of this transdisciplinary field of research: "the use of appropriate skills, media, activities, and dialogue to produce one or more of the following personal responses to science). This definition includes a vowel analogy: A – Awareness, including familiarity with new aspects of science; E – Enjoyment or other affective responses, e.g. appreciating science as entertainment or art; I – Interest, as evidenced by voluntary involvement with science or its communication; O – Opinions, the forming, reforming, or confirming of science-related attitudes; and U – Understanding of science, its content, processes, and social factors" (*Idem, ibidem*). The authors state that science communication contemplates the involvement of different actors (lay people, scientists, mediators and others) – in sum, all those involved in both science and (broadly) society.

Health Communication - Improving health through communication

In science communication there are many topics related to the different fields of science, however there is certainly a few that are more popular than others, for example the field of medical science, since health and disease concerns everybody's interests (Wagner, 2007). In this sense, health communication is a subdomain of science communication. And it is not a minor one, since health is a public issue, as well as cultural, economic and political ones – directly and indirectly concerning to "all of us".

Health is a global concern with a crucial role in society, since it is an essential determinant for the citizens' wellbeing. Diseases affect the quality of life and have a significant impact, not only at the individual level but also on communities. Health is not merely the absence of disease, but as long ago stated by the World Health Organization [WHO], a state of wellness (1948). In reality, the better we know the research strategies that lead us to become aware of the risks for health, the strategies of intervention can be more or less regulatory, invasive and linked to social, political and ethical questions (Massé, 2007). Under these circumstances, communication especially health communication, assumes a determinant role to improve the dark epidemiological, clinical and social scenario involving disease.

There is no single definition for health communication indeed it is a subdomain of the communication science field – a "young" multidisciplinary scientific domain. Health communication can be viewed as a process with four essential elements: sender, receiver, message and channel (Wright, Sparks and O'hair, 2012). Despite these essential elements of communication, Schiavo (2007:7), defines health communication as “a multifaceted and multidisciplinary approach to reach different audiences and share health-related information with the goal of influencing, engaging, and supporting, individuals, communities, health professionals, special groups, policy-makers, and the public to champion, introduce, adopt, or sustain a behavior, practice, or police, that will ultimately improve health outcomes”.

In brief, different forms of communication such as interpersonal communication or mass media, specially in which concerns to health communication, have the potential to influence health behavior and attitudes and increase health knowledge for the prevention of disease and the promotion of health and it can raise individuals' awareness of health risks by informing them of potential threats they may face (Moore & Spiegel, 2004; Blake, Flynt-Wallington and Viswanath, 2011).

Although recent, the health communication arena has been influenced by different models of illness and healthcare. The so-called biomedical model dominated the last century, where health is only related to the body, separated from any psychological or social process. It only focuses on biological aspects of diseases (Wade & Halligan, 2004; Stephens, 2008).

However, more recently the biopsychosocial model and the social model of health emerged and are replacing the biomedical view in health communication. Unlike the biomedical model, the biopsychosocial allows a holistic approach of health, integrating body, mind and social life (Wade & Halligan, 2004; Stephens, 2008; Moore & Spiegel, 2004), while the implications of social interventions explicit in the social model emphasize the power of context on the spectrum of illness (Wade & Halligan, 2004). Although these new models of health communication covering other components intrinsic to human life, in western societies the biomedical model is still being widely used among health professionals (Moore & Spiegel, 2004), and reflected in the different actions regarding public health, health promotion and disease prevention.

Health campaigns are not only dependent on the participants that send or receive the message and the channel used to do it. In fact, there are matrixes that need to be acknowledged and must be taken into account such as the cultural context. It is essential to know the cultural background of the campaigns' target in order to produce effective changes in behavior and ultimately social change, which might be particularly evident when a system of values and practices are inherent to those behaviors (Wright et al., 2012). Moreover, traditional health communication campaigns are conceptualized as a persuasive top-down approach, with the flow of communication starting from authority entities to border locations. This top-down approach is not efficient because it is essential to understand local contexts and prioritize the risks or the messages that need to be delivered. On the contrary, a bottom-up approach, in terms of communication, can provide to populations the necessary tools to make health campaigns be more effective.

In the study conducted for this dissertation a similar strategy to a bottom-up approach was used (in terms of extension, reaching different groups of the school community, teachers, students, families), being teachers the "core of communication", with the capacity and the necessary tools to act and engage with their targets, the members of the school community. Besides that, there is a permanent interaction created in this flow of communication that allows all the participants involved to be free to create their own connections and changing their position in the flow.

It should be noted that, for the authorities responsible for public health and for the health care providers, health communication activities on the one hand are designed to promote individual health and patients education and on the other hand are part of a constructive strategy to inform or influence public health.

In general, health campaigns can be classified either as informative or persuasive in terms of their goals (Atkins & Rice, 2013). Campaigns may have different goals such as improve

awareness or basic knowledge of the target audience about an illness, change attitudes and the ability to deal with a particular illness or physical condition, or, finally, promote behavior change in relation to a specific action (e.g. the use of a new screening method) (Logan, 2008). In general, research due to that actions intended to review the progress in the audience at different levels, among which are: a) awareness and knowledge - knowledge about a disease; b) attitudes - emotional dimension, feelings and motivations about a disease; c) behavioral conditions - intent on getting help or assistance.

It is essential for the sphere of health communication campaigns to know and test the role of different determinants such as culture, media, familiar and interpersonal contexts (Dutta-Bergman, 2005).

Why are health campaigns so important for health promotion? As already stated, the development of many diseases, such as cancer, are mostly caused by behavioral options, then prevention campaigns could be used in order to address these external factors that are contributing to health decline.

Prevention is, however, a very complex issue. Authors like Snyder and Hamilton (2002) and Dutta-Bergman (2005) argued that health campaigns regarding health promotion or disease prevention have not managed to foster significant behavior changes, only achieving small and short-term effects.

Dutta-Bergman (2005:106) added that health campaigns “(a) are individualistic, (b) ignore the context within which communicative meanings are constructed and negotiated, and (c) are cognitively oriented”. Some health campaigns, including cancer prevention campaigns, are based on real facts while others resorted to fictional production to create the message (Logan, 2001; Dejong & Winstein, 1990), however, most of them use media as the preferential channel for disseminating their messages (radio, television, newspapers) and more recently social media.

Besides the media, dissemination of information occurs sometimes through more traditional methods like leaflets, brochures and even outdoors. In some cases, the use of these different communication channels is further reinforced by the action of other institutions that promote health education. Still, the use of these channels was proven to be ineffective. Some authors suggest that due to the changes that have occurred in the media, but mainly due to the emergence of new forms of social networking and interpersonal communication provided by the Web, including blogs, social networks, forums, health communication requires nowadays the use of innovative approaches (Randolph & Viswanath, 2004).

Throughout the 20th century, the popularization of science (often associated with financial support for medical research and its legitimization) was a key factor in the integration of media

in health campaigns (Bauer, 2008) that provided a focus in the media and not on the target of the campaigns, the public, to whom the campaigns were addressed.

Today, this idea is quite obsolete and emerging conceptual frameworks emphasize a cognitive and behavioral approach that promotes the individual's ability to learn to use information and knowledge in decision making, particularly in the oncology health campaigns (Logan, 2008).

Cancer Communication – Strategies from Health Communication customized to a specific context disease

Assuming prevention as the most effective strategy in order to reduce cancer incidence and mortality, health campaigns regarding cancer are planned at different levels (adopt healthier attitudes and behaviors, screening, diagnosis, treatment), being one of the most used strategies to fight cancer in the realm of health communication (Wright et al., 2012). However this is a major task with many obstacles, for example: how to “convince” people in order to change their unhealthy behaviors or to adopt healthier attitudes? How to maintain a healthier behavior? The answer is in the way we communicate, how we make communication effective – it is a question of a relational-model.

In cancer as in other diseases, communication should be the key for success on health promotion and disease prevention, so it is urgent to define which are the best ways to communicate in each situation.

Our perspective is that the nature of the campaigns and their elements are essential to determine their success. Until now the focus have been on the channels used to deliver the message and how the message flow from the sender to the receiver (Dutta-Bergman, 2005). The information contained on the message is another central element in any kind of communication movement. Indeed communication should be based in a two-way exchange of information. Information is intrinsically connected to the individual and the group capacity to read or listen and understand the message transmitted. This capacity, literacy, is essential for any communication process. The same happens for communication in health, health literacy, or in this case, cancer literacy is a mandatory condition for effective results.

To put it simpler: “theories [we should add: and the practice models they allow] about the public communication of science have until now focused essentially on two aspects: the incapability of the actors and the inadequacy of the means” (Cheng et al., 2008: 1); on the contrary, our thesis is that the actors are capable of active and critique self-mobilization if the means are adequate. Nevertheless, it is in accordance with Trench (2008), when he suggests that, depending on the real circumstances, the models should be porous, flexible, then eventually mixed. The same could be applied in health, especially in/for cancer communication. As we shall demonstrate, our health (cancer) prevention model, albeit participatory, contains some elements of the dialogue model: it is focused on the teachers, who are expected to mobilize their role and status to develop their own campaigns in schools.

In health communication research, the ultimate goals are always to influence behavior change and promote social change. Many factors are linked to change and it is necessary a solid framework based on different theories (behavior and social change theories) and disciplines (health education, social marketing) (Schiavo, 2007). The different strategies used to communicate in health are the reflection of the application of this complex framework in order to achieve not only the changes at the individual level (behavior change) but also on groups or communities (social change). The argument supporting that complexity can be found in Cheng et al. (2008:2): “Today, communication is seen as a necessary (but insufficient) contribution to science and society’s dialogue to reintegrate science within culture. The social role of science goes well beyond scientific knowledge and its intrinsic merit; it resonates in the forms and functions of contemporary organization. Their importance in our modern life means scientific thinking and activities are not outside culture, but well within it”.

Epidemiological, Cultural and Social perspectives on “Cancer Epidemic”

Being cancer one of the leading causes of death worldwide is nowadays considered an “epidemic” for the 21st century, especially due to the significant challenge that represents to our society, in terms of economic impact and social burden (Wright, Sparks and O’hair, 2012).

Epidemiological information on cancer reveals that cancer burden will continue to increase in the next decades, so the control of cancer incidence and mortality rates remains a primordial target for national health policies (Chang & Collie, 2009; Mellstedt, 2006; Jemal et al., 2009; Jemal et al., 2011; Sener & Grey, 2005; Gouveia et al., 2008). This information is crucial in order to “plan and evaluate strategies to prevent illness and as a guide to the management of patients in whom disease has already developed”¹.

Similarly to what happens in the rest of the world, Portugal is not an exception in the cancer scenario. Cancer is the second major cause of death, only exceeded by cardiovascular diseases (Ministry of Health – National Health Plan of Portugal, 2012). However, this trend is changing, recent data shows that cancer mortality among Portuguese men already exceeded cardiovascular diseases (Pereira et al., 2012). Within the Portuguese population, there are variations in terms of gender: mortality is globally higher among men than among women; breast cancer remains the leading cause of women mortality while men higher cancer mortality rate is due to lung cancer. On the other hand, for both men and women, the organs affected by cancers with high mortality rates are colon and rectum, lung and stomach. Regarding the incidence of cancer, prostate and breast cancer are the most incident in men and women, respectively; and colorectal cancer is the second major incidence, affecting both sexes. Men are also widely affected by lung, bladder and stomach cancer. Within women, the cancer that affects the corpus and cervix uteri is in the third place followed by stomach cancer, as shown by GLOBOCAN 2012 (Ferlay et. al, 2012).

As expressed by these statistics, cancer has a profound impact in Portuguese society and different social agents and institutions play an important role in the search for new information and minimization of the risks associated with this disease.

Furthermore, worldwide statistics also provided by epidemiology revealed that more than half of the deaths caused by cancer are due to incorrect behavioral options that can be avoided by the individuals (Colditz & Wei, 2012, Wright et al., 2012). Each one of us should

¹ What is Epidemiology?

Available at: <http://www.bmj.com/about-bmj/resources-readers/publications/epidemiology-uninitiated/1-what-epidemiology>
 (Last access: 20/02/2014)

intervene as early as possible in changing their habits and routines, specifically their nutrition, physical activity, sexual risk behaviors, consumption of alcohol and tobacco.

Avoiding the exposure to these (and other) risk factors (risks associated with the diseases, which means the conditions that increase the probability of developing a certain disease), the probabilities of getting sick significantly decrease (Massé, 2007).

Prevention, in its wider sense, is consensually assumed as the best strategy to reduce risk factors, especially in which concerns to cancer “epidemic”.

Every day hundreds of people continue to be diagnosed with this “plague” as a consequence of ineffective programs of prevention, namely primary prevention interventions and early detection and screening, that could reduce the incidence and more important the mortality rates. Preventive actions and behaviors should be considered in order to avoid or diminish the burden not only of cancer, but also of other diseases.

Prevention is categorized in different levels. First one and more effective, according to our research goals is primary prevention, i.e., the actions taken when there are not any symptoms of the disease, illness or injury, in other words any procedures regarding our healthy behaviors are considered primary prevention. The second level, secondary prevention, corresponds to the measures that allow early detection or diagnose of a certain disease, increasing the probability of success in the treatment. This level is strongly associated to screening exams that detect the disease. Finally, tertiary prevention is applied when the disease is already installed: preventive measures are taken in order to rehabilitate or decrease patient suffering (McKenzie, Neiger and Thackeray, 2013).

In cancer communication, the focus has been mostly between healthcare providers and patients, since tertiary prevention represents a big part in prevention. Effective communication must be the imperative for the success of cancer campaigns, regarding primary and secondary prevention, in other words, the messages “avoid risk factors” and “improve early detection and diagnosis”.

There are social and cultural factors that are associated with “cancer epidemic”. For many years, especially in the last two centuries when cancer appeared as an all-time “evil”, scientists all over the world and from different fields of knowledge tried to understand the disease and find a cure. Despite this greater effort cancer researchers failed to discover the “magic pill” (a new drug or chemical with the capacity to eradicate any type of cancer at any stage) (Mukherjee, 2011). However there are many advances, regarding screening tests, diagnostic tools and targeted therapies that in many situations transform cancer in a manageable chronic disease.

Nonetheless, the most recent clinical advances were not enough to decrease the number of deaths and to change a profound stigmatized and stereotyped concept of the disease (people seen it most of the times as “the end of the line”). Cancer embodies a paradox that combines fear with evasion, in a society driven, at the same time, by values of happiness, beauty and hedonism (Lipovetsky & Serroy, 2013). The question that arises is how we can manage the incidence and also mortality rates without an effective “clinical cure”?

As referred, cancer is seen most of the times as “the end of the line”, talking about that in our society is, most of the times, talking about myths that have been fabricated throughout time. Most people consider cancer as a contemporary disease, a “20th-century evil” caused by the environment, especially radiation and pollution (Burgess, 2004). As shown by Mukherjee (2011) it was not always so throughout time, the history of cancer and oncology suffered ups and downs, especially after the scientific revolution, until then little or nothing was known about the disease, although cancer was already known by the Egyptian civilization.

Mediatization in our “information societies” (Castells, 2001) contributes to debilitate our common confidence grounds: this is a reversal of the “pure” vision of science and technology, ushering us to feelings of fragility and powerlessness, especially regarding to health.

The above issues allow us to put the question of cancer as culturally-driven. In fact, the two elements, contemporary information and mediatization, brought the lack of (blind) confidence: the legitimation of science is an actual issue in our contemporary world, and a very important one, concerning our perspective for cancer prevention.

Health communication provides critical tools to educate citizens, increasing health literacy and to promote behaviors towards prevention.

As it can be seen, besides the social and cultural context and its influence on behavior change, the capacity to understand health issues, health literacy, is also determinant for the success of health campaigns, namely for prevention campaigns. This study is focused on the idea expressed by Davis, Williams, Marin, Parker and Glass (2002) as it “is increasingly recognized as a crucial issue affecting communication across the healthcare continuum”.

Cancer Literacy - A particular challenge inside Health Literacy

Over the last decades health research experienced major improvements, especially in what concerns health promotion. This expansion strengthened the relation between citizens and healthcare systems and brought to the top the concept of health literacy. It is in this context (1970s) that this concept emerged and has been discussed until now (Sørensen et al., 2012). Recent research shows that health literacy does not gather a consensus on its definition; it is a multidimensional term that is looked from different perspectives all over the world, using distinct conceptual models.

According to the WHO, the cognitive and social skills which determine the motivation and ability of individuals to gain access to understand and use information in ways which promote and maintain good health (Nutbeam, 2000) were the main skills to represent health literacy.

Another definition and one of the most used in the North American context, describes it as “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions” (Ratzan & Parker, 2000 *in* Institute of Medicine [IOM], 2004).

In European Union (EU) the concern towards health literacy is more recent, with a different emphasis from the North American approach. The first definition released in EU for health literacy describes it as the ability to read, filter and understand health information in order to form sound judgments (Sørensen et al., 2012). Another important milestone for health literacy in Europe are the four dimensions attributed by The European Health Literacy Project to the term health literacy: accessing, understanding, appraising and applying information to health making-decisions (Kaphingst et al., 2012). The dimensions attributed to health literacy in the European project are applied in a broader sense regarding determinant aspects for its definition. Currently, in EU there is a major effort to integrate this term in a broader way regarding the citizen's cognitive capacities, the context where they belong and also the public health policies (HLS-EU Project, 2012).

A health illiterate individual has a higher probability to have a poor health status, a lower quality of life and a shorter life expectancy. Research studies indicate that low health literacy could increase poor health outcomes, higher risk of disease and disability, higher use of healthcare services, (specially the emergency services) and a higher risk for hospitalization, which increases the healthcare system costs (McCray, 2005). There are also multiple socio-demographic aspects that contribute to limited health literacy, namely low education level,

low socio-economic status, age (older people are intended to be more illiterate), gender, ethnicity and language.

Decision-making and its relation to disease prevention is one of the most important topics in health literacy research. In other words, what are the best ways in which researchers can help to improve the level of literacy about health in citizens in order to prevent diseases like diabetes, obesity or cancer. As the cancer incidence and mortality will be raising in the next decade, according to different studies, and since it is a disease of elderly population with a profound impact on ageing societies, it is urgent to develop new policies and strategies that can reduce the cancer burden (Diviani & Schulz, 2011).

Most of the studies conducted in health literacy research, approach patients and their ability to make important decisions towards the health information that are presented by healthcare professionals, the emphasis is on patient education. In this scenario, primary prevention and other subjects are disregarded and there is a lack of studies that could improve not only prevention but also other dimensions of health literacy and specifically cancer literacy.

As noted above, health literacy incorporates an operationalization of its definition related to functional literacy, basic skills as the ability to read and write. The same happens for cancer literacy when we try to describe the term. The first attempt to elaborate an operational definition for cancer literacy refers to it as all the knowledge a layperson needs to possess to understand the information and advice the health system has to offer with regard to preventing, diagnosing and treating cancer. Based on this definition it may be noted that the ability or the skills that we need to understand the information are transversal to all subjects in health while knowledge is specific of a subject or context, in this case of a particular disease, cancer. On the other hand if we look to the multiple health literacy definitions they are constructed in a broader sense so a specialization of the concept according to a certain area might be more useful to understand the impact of literacy in health outcomes (Diviani & Schulz, 2011).

The same authors stated that a cancer literate person should be more able to seek preventive medical checkups and be susceptible to well-founded advice on disease prevention, which is a crucial issue for health economy, improving public health resources. This could be expressed in one word, prevention. As seen above knowledge should be emphasized in which concerns health literacy, especially regarding specific disease contents as a way to develop more specialized skills and capabilities to perform sophisticated tasks (Diviani & Schulz, 2011).

Regarding the cancer setting, prevention is a determinant topic to reduce cancer incidence and mortality, so it is still necessary to make people aware of prevention strategies.

Increasing knowledge it is a crucial point but does not guarantee the adoption of preventive behaviors. Action, in the way which skills are mobilized to understand knowledge, is also needed in order to raise cancer awareness (Hawkins, Berkowitz and Peipins, 2010).

Knowledge is also related to the information need and education level. Individuals with a low educational level need more health information to get the necessary knowledge that makes them literate in health (Matsuyama, 2011). They also need information appropriate to their sociocultural context.

Low cancer literacy could have serious implications to an individual's quality of life, especially in which concerns cancer prevention: risk behaviors, participation in cancer screenings and stage diagnosis. This can only be improved with a closest collaboration between researchers and healthcare professionals and their ability to communicate with individuals about their health status, particularly when it concerns to cancer (Merriman, Ades and Seffrin, 2002; Davis et al., 2002).

In order to improve cancer literacy it is necessary to know all its determinants, such as knowledge, skills, information needs, so the first step is to understand what people really know about cancer and what are the cultural and social characteristics associated to literacy in cancer (Diviani & Schulz, 2011).

If we constrained the scope of health literacy and focus on a specific disease context such as cancer, the dimensions that are currently assessed with the most common health literacy tools are quite different. In the cancer spectrum, and since recent therapeutic advances are evolving cancer into a status of chronic disease there is an increasing concern regarding prevention and specifically, screening and behavior. This is strong evidence that more research is needed in order to improve distinction between distinct particular contexts of disease and illness that could be useful to describe and manage some health related behaviors, reinforcing the assumption that health literacy, as a one-fit-all concept is too general and in part meaningless, so the importance is on disease-context literacy.

Another important point is that health literacy is strongly linked to attitudes and adherence to screening programs and the adoption of healthy behaviors which regarding cancer plays a key role for health promotion (Diviani & Schulz, 2012).

As already referred, health literacy, specially cancer literacy, regards to all the knowledge that a layperson needs to possess to understand the information to deal with the disease prevention, diagnosis and treatment.

Schools role on Health Literacy – The Portuguese context

Having in mind the atmosphere of tension, doubt and uncertainty (in sum: miscommunication), we argue that schools, although sharing the contemporary institutional crisis, continue to play a fundamental role on both knowledge reproduction and general socialization. In some aspects, the institution has reinforced its role and expectations, given the increasing amount of time that children and adolescents spend inside the school space, the entrance in the school being progressively premature, and, in many European countries, the compulsory education having been extended throughout time. Despite this scenario, school has been unable to deal with massification, which in this case does not necessarily mean homogenization, but a necessity to deal with cultural and social difference. Moreover, the rapid changes that globalization has brought (Information and Communication Technologies (ICT) and a fast flow for information) have not been incorporated into an opening of the school curricula. These continue to be focused on technological and scientific culture instead of focused in new ways to adapt school for social change (Bourdieu, 1999).

Nowadays many people would agree that our schools are too much specialized and the same people would think that will be impossible to change it. Now we are able to continue specialization but we are unable to rethink and simplify education at schools.

Different social agents and institutions play an important role in the search for new information and minimization of the risks associated with this disease. It is also known that health knowledge is deeply related with science knowledge.

Unfortunately, in the reality imprinted there is lack of full and systematic epidemiological studies that would gather data for more precise and causal knowledge, specially regarding social and cultural issues as well for the identification of target groups for prevention and cure hypothesis. Under these circumstances, it is urgent to explore and determine priorities, and implement on the ground the available conclusions obtained in research, thereby reducing the negative impact on citizens' culture, knowledge and consequently on their health literacy.

Taking into account what has been described above, it is evident that across the world, as well as in Portugal, there is a gap on the battle against cancer, from prevention and screening to its diagnosis and treatment.

Regarding the Portuguese context, the reason for this information gap is the absence of national policies for cancer prevention and early detection as well as the immaturity of National Oncologic Plan. This is directly reflected in the lack of knowledge of Portuguese population, in particular young people, about these issues.

Another important factor that contributes to this situation relies on Portuguese culture, including scientific culture. In a traditional way, according to Trindade (1994), Portugal is a country of tradition and also a country of contrasts.

During many centuries science in Portugal was not tolerated at all, specially by religious, social and political questions, so there was no opportunity to disseminate scientific culture as it happened in other European countries at the time (Fiolhais, 2011). There were two important historical barriers that contributed to this delay in Portuguese science: inquisition and dictatorship. However, the end of dictatorship in 1974 and the entrance to the formerly European Economic Community (EEC) in 1986, nowadays the European Union, allowed the first opening to the importance of science and scientific culture. In fact, this openness was very important, anyway it had suffered advances and setbacks that would only be consolidated along the 1990s. This was due to a sociocultural enclosure anchored in high illiteracy levels of the population (Benavente, 1996), which constituted an obstacle to an open relationship between science and culture (Fortuna & Silva, 2002).

Despite all of these efforts the special *Eurobarometer 2010*, in Science and Technology (European Comission, 2010) continue to reflect a gap in the interest of Portuguese society in science and scientific culture. Portuguese are not very confident in science, which leads us to health questions, especially when we talk about severe diseases like cancer or neurological conditions that is undoubtedly a big part of the scientific research picture of nowadays.

So the next topic on this introduction presents a global view of a project developed in order to contribute to the increase of cancer literacy and consequently to reduce the burden of this disease.

“Cancer, Educate to Prevent” – A new model based on school potential for cancer prevention

This research is focused on health communication as a complex field, where there is still a lot to be understood and accomplished to articulate science and society, in two directions: science (experts, institutions) must learn to communicate with lay people, especially concerning prevention, but social institutions have a crucial role to play in order to mediate that connection, so that it can interact with common people. It is a question of “translation”, both from science to society and from society to science, according to the different contexts. One of the core assumptions for our study is the evidence that the increase of information flows without a corresponding increase of knowledge tends to shatter any confidence in abstract systems (Smith, Singer & Kromm, 2009).

Currently, cancer prevention education programs are mainly developed and delivered by healthcare professionals, as also by many institutions, such as universities, public health schools, medical centers and other organizations that care about cancer, some are also governmental campaigns or have the government support.

The nuclear argument of this research is that these programs may be more efficiently delivered at specific targets, in this case schools, which constitutes an innovative approach, in order to enhance impactful and durable changes in society. In order to support this argument, evidences indicated that tailored and targeted communication strategies are part of an approach to adapt health information to individuals and groups as well (Blake et al., 2011).

We believe that health is a privileged issue, as it deals with body, sexuality, lifestyle, identity, family history and community traditions. Health concerns "everybody's" interests and cancer is one of those interests, also perceived as a threat and a psychological trauma for many individuals and families (Moore & Spiegel, 2004). In addition to that, some experience in arts education programs may help to improve health education programs (Do, Gentil, Poncet and Régnier, 2006; Wagner, 2005). Besides (and very important for the goals of the study towards health education), schools are privileged places for informal sociability and thus for social identity construction, especially through the groups' affiliations.

Schools have indeed a privileged role in this process. Being the socialization institution per excellence, culture and knowledge are expected to reproduce and develop through school. In developed countries, children go to school sooner than before, and leave it later. Young people stay long periods of their day in school, where they tend to socialize with their

friends. Although our education paradigm is in crisis (along with the whole social paradigm), school and its specialists – teachers – are still the most important elements for social mobility and awareness.

Under these circumstances, teachers should be appointed as preferential mediators between students and their families that is why we argue – and experimented it – that the probability of successful health prevention depends on schools and teachers, and though them it is more likely to reach families and the whole society.

Social change cannot be dissociated from concepts such as: perspectives, scales, models, traditions, time and identity. Tradition is one of the most important concepts for this work. This concept is a cultural reference for the actors that contribute to the social processes. Also involves space and time, essentials characteristics for social practices that acquire a global and objective dynamic where it fits action and social interaction. Society is an open and dynamic system so tradition is not also a static thing it evolves (Silva, 1994).

Scientific culture is generated within the scientific field, which has developed its own autonomy and, correlatively its own power (Bourdieu, 1999). The relationship between science and society (*sensu lato*) is changing, increasing the complexity of domains like health and disease prevention. The presence of socialization instances and the hegemony of media weaken “social order” and the need for an integrated perspective is required in order to change values and practices. Social change requires action and interaction, regulated by social mechanisms and applied to groups or collectivity.

The goal is to contribute to a fruitful interaction between science and society, mediated by the school and its agents (teachers and students) with the argument that social change is, first of all, a cultural change, and that this must take place through target actions with specific groups, in order to generate relations with other groups and thereby lead to successfully transformations.

We are confident that engaging people is the best strategy to generate profound transformations. A real social change implies in-depth interventions for the development of skills that allow new practices and autonomous reflection.

We consider social fears and preconceptions about cancer as the main field where social processes have to interact in order to change the relationships between society and science. As Cheng et al. (2008: 1) put it: “Science is not another culture, alien to society. It should be considered as a substratum, a *déjà-là*, a base from which meanings elaborate and evolve, in turn yielding a coherent vision of our actions and our situation, but also our will to understand, to communicate and to act”. Increasing cancer literacy and rebuild attitudes that

promote cancer prevention are the focus of this intervention with the adequate communication strategies.

Schools have then a great potential as a social context for those who have a role as agents of prevention. The school environment has a high potential in cancer prevention, not only in school community members, teachers and adolescents but also on the whole community.

Finally, is assumed that teachers are privileged agents for a triangulated mediation - schools, students and families. It is undertaken that in this project families play the role of *indirect targets* in our prevention program.

The research presented here was conducted through the project “Cancer, Educate to Prevent”, a pilot study focused on school community that aimed to understand a reality shaped by the traditional health prevention campaigns, as well as to transform that reality (in the perceptions, knowledge and, ultimately in the behaviors of the targets: teachers and students).

This innovative model has as bottom line, the training program for biology teachers. During the training program teachers were skilled to actively contribute to develop and implement their own prevention campaigns focused on students and local communities. The training encompasses two distinct components: an educational (different educational modules of the training program ranging from cancer biology to prevention campaigns design) and an interventional one (involving the design and implementation of prevention campaigns by teachers at school). Teachers’ and students’ perceptions and knowledge about cancer and prevention were assessed in three phases, with questionnaires: i) at the beginning of the training program (pre-test), ii) immediately after the end of the training program (post-test) and iii) one year after (follow-up), as well as the essential socio-demographic characteristics that could be useful to interpret the data obtained. The whole project was focused on four types of cancer: breast, cervical, skin and colorectal cancer that have a major impact in Portuguese society (Ferlay et al., 2012) in which refers to its risk factors and prevention. In which concerns to teachers they were also evaluated regarding these types of cancer, but in a different way. Their knowledge was evaluated in the areas of: cancer biology, prevention, epidemiology and scientific literature databases.

For this research, the bottom line is that rethinking education is to rethink culture.

It was developed an innovative approach for cancer prevention education and opens a new perspective for the development and validation of cancer prevention education strategies, based upon focused interventions in restricted targets (students) through non-healthcare professionals (teachers).

This research was conducted at the Institute of Pathology and Molecular Immunology of the University of Porto (Ipatimup). These institution occupies a privileged position to address this problem, given two important reasons: i) it has already a long and internationally recognized history in scientific research on cancer; and ii) it has a long experience in early diagnosis of cancer and cancer awareness activities for students, teachers and the general population through the Public of Cancer Awareness Unit. In this context, the work presented in this dissertation was part of the project “Cancer, Educate to Prevent”, supported by the Portuguese High Commissioner for Health (ref# O10-98).

This dissertation was written based on the scientific articles that were submitted and published during the development of the different stages of the research conducted.

The first chapter of this dissertation is focused on the paper “The Cancer Educate to Prevent model – the potential of school environment for primary prevention of cancer”, which rely on the presentation of the whole development of the project, including the different perspectives that contribute to the creation and implementation of a new model for cancer prevention education and its methodological strategies.

Chapter two of this dissertation rely on the baseline characterization of cancer literacy levels of the students that participated in this research, as well as the design of an instrument to measure cancer literacy documented in the scientific paper “An unexplored potential to reduce cancer burden of future generations - improving the low levels of cancer literacy among adolescents”.

In chapter three, that corresponds to the paper “Cancer – Educate to Prevent – High-School Teachers, the New Promoters of Cancer Prevention Education Campaigns” will be described the training program implemented with biology teachers and the results obtained not only on teachers knowledge and perceptions but also the impact of their own cancer prevention education projects on students cancer literacy. It also includes the main characterization of the projects developed by the teachers as well as the evaluation of the whole training program.

The results obtained allowed us to understand the cancer knowledge that they have and provide us the necessary tools to design, target and tailored campaigns/messages that will help to increase cancer literacy.

Finally, this dissertation ends with a major conclusion of the results obtained with this work, as well as future lines of research.

Chapter 1

“The Cancer Educate to Prevent model – the potential of school environment for primary prevention of cancer”

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Abstract

Cancer represents one of the main causes of death worldwide, so prevention campaigns related to cancer are one example of this situation, whereby preventive interventions are of utmost importance.

The leading model of health prevention campaigns is based on general and undifferentiated actions mediated by health professionals, focusing on the technical and scientific information but rather ineffective in its changing impact of symbolic, cognitive and practical relationship with the disease.

This pilot study emphasizes the feasibility of cancer prevention programs planned as focused interventions in restricted targets and mediated by non-health care professionals to increase cancer literacy and promote preventive behaviours, as it assumes that early interventions targeted to specific groups can contribute to positive and durable changes in cancer prevention.

Our aim is to understand a reality shaped by traditional health prevention campaigns together with the evaluation of schools' potential as a vehicle for cancer prevention education. We developed a protocol of systematic surveying in order to review and, in the future, optimize and replicate this ecological model to other groups and contexts. So far the implementation of this model has been successful in which concerns to the effectiveness of the training program for teachers that led to the development of cancer prevention education projects by trainees target to their students, allowing us to argue that it contributes to knowledge and practice in this complex as consensual priority area of intervention.

Introduction

In our society, health concerns *everybody's* interests and cancer is a well-known example of a one of the most prominent diseases nowadays, perceived as a threat and a psychological trauma for many individuals and families due to the high incidence and mortality rates worldwide [3, 13]. It is also recognised that more than half of all deaths resulting from cancer could be avoided once they are attributed to inadequate behavioural options [7]. In this scenario, interventions regarding cancer prevention are of utmost importance.

The study presented in this paper proposes an innovative model for cancer prevention education, focused on the potential of the school community as a privileged environment for health education with effective impact on behavior and social change. The model was designed for the “Cancer, Educate to Prevent” project, reinforcing the role that high school teachers can have as cancer prevention promoters in schools by targeting students. A training program was developed and applied, so that the teachers were able to independently develop and implement prevention campaigns focused on students and school-related communities. The program encompassed different educational modules, ranging from cancer biology to prevention campaigns design.

Our goal with this model is to contribute to an increase of cancer literacy (both on teachers and students), which is a critical condition to promote behaviour change. Consequently as this model is focused on the potential of the school environment, it promotes shifts in individuals' behaviour that are part of a larger community (school community), stimulates social change and can also have impact on families and local communities.

This cancer prevention educational model is based on an educational and ecological approach, where it is important to recognize the context/environment, the school, and the relationships established between the individuals of the school community (ecological approach), and also recognize its history and traditions (educational approach) in order to improve health outcomes regarding cancer prevention [11].

The school environment and the teachers' role

School environment has a great potential in cancer prevention among teachers and students but also on families and local communities. Moreover and very important for our goals towards health education), schools are privileged places for informal sociability and thus for social identity construction, especially through the groups' affiliations. Primary and secondary levels of socialization [2], could than help to change such behaviours, thus education is the stepping-stone for durable behavioural change, through knowledge and

cultural awareness. It is important to know that this contributes to a fruitful interaction between science and society, mediated by the school and its agents (teachers and students) with the argument that social change is, first of all, a cultural change, and that this must take place through target actions with specific groups, in order to generate relations with other groups and thereby lead to successfully transformations. A real social change implies in-depth interventions, as we propose in this model for the development of skills and abilities that lead to autonomous reflection and new practices.

Teachers are the school *brokers*: in addition to being object of prevention education they play a natural role of mediation in all types of education programs. As the leading agents of school socialization, they perform a triangulated mediation, interacting with the school, the students and their families. More important to our arguments is the fact that their institutional position is privileged to develop close relationships with their students. For example, children and adolescents are known to sometimes trust their teachers for problems and doubts that they do not share with their parents. Teachers are indeed *active* social mediators (in the sense of Mason, when he refers to them as *critical mediators*) [15] and thus they are key players for cognitive and practical (behavioural) changes. We assume teachers are privileged agents for a triangulated mediation - schools, students and families. It is undertaken in our project that families play the role of *indirect targets* in our cancer prevention education model.

We have chosen the biology teachers as focus-mediators. As experts in biological scientific knowledge, biology teachers were expected to be more *intrinsically* motivated for cancer prevention than other disciplines' teachers due to their background [17]. Moreover, the contents they teach are related to our prevention object, and most of the times they are responsible for the health education programs at schools. Finally, biology teachers are often the first person that students contact when they need to spell out doubts, fears and worries about health that in some way are related to the contents they learn in classes.

In sum, biology teachers are expected to be especially predisposed, and more prepared than others to develop projects focused on cancer prevention. This was the key point of teachers training. It is expected that training is valuable in health education and promotion, as biology teachers combine expertise with an important role in adolescent's health education.

The potential of youth for primary prevention of cancer

Cancer is not a typical disease of youth although there are some types that are characteristic of this period of life, namely leukaemia, lymphoma, brain and central nervous

system tumours, bone and soft tissue sarcomas and others [20]. It is more common to associate a cancer diagnosis to an older person than to a young person [20], especially in developed countries, where aging populations are fuelling the burden of cancer [3, 13, 19, 5, 10]. However, aging is not the only factor associated with cancer: more than half of the deaths from cancer are attributed to unhealthy behaviour options [7], which in many cases are shaped during adolescence like, for example, tobacco consumption [14]. This is why adolescents and young adults are the preferential targets because they are in the age of *active learning*.

Throughout life, humans go through a process of integration of the social and cultural elements. These elements will be part of human personality, being influenced by experiences and social agents (such as schools) that have a significant role in integration and development that allows adaption and the definition of social environments [16]. In this sense, individuals develop knowledge, models, values, practices and symbols that are inherent to groups and communities such as the school community, which will go all along the socialization process, seen as a plural, reflexive and cumulative process [2].

Student's demographics in high schools typically range from 15 to 18 years old. They are in adolescence, a stage of transition between childhood and adulthood. The definition of adolescence involves three components: biological – comprising puberty; psychological – that integrates the psychological typical characteristics of this stage of development and developmental tasks; and sociological – covering cultural specificities of demands placed by society. Psychological and sociological components are crucial to the psychosocial and moral development of the individual.

Since this is a phase of transformation and building, it will be easier to see a change in their attitudes and behaviour in relation to the lifestyle that should be adopted to promote the prevention of diseases such as cancer. Also, during this phase, young people have a capacity to influence mutually, when adopting particular lifestyles in regard to risk behaviour. Behaviour and social change are effective if we change the way we educate people. So education is the key for these changes, namely health education in early ages.

Briefly, in this study we addressed some questions that in the end will be the support for the relevance and feasibility of this model: i) What are the ideas and perceptions (social representations of the disease, cancer literacy and preventive behaviours toward cancer) shaped and shared by people, specifically among teachers and students, that result from the influence of social and cultural experiences on cancer?; ii) What are the implications of social (socio-demographic and economic characteristics) and cultural (scientific and “social” cultures) contexts, as well as the interactions between them and their influence on health

promotion, specifically for cancer prevention?; iii) What is the best methodological strategy to understand and transform this reality?; and iv) What is the impact of this type of actions in the specific target groups of the study?

Finally, we will detail our project, its methodology, implementation strategies and general results. The project aimed to characterize the social and cultural contexts of cancer representations, knowledge and practices, while implementing an innovative model based on education for cancer prevention targeted to the school community.

Methods

“Cancer, Educate to Prevent” – The pilot study and its methodological strategies

“Cancer, Educate to Prevent”, was a pilot study focused on school community that aimed to understand a reality shaped by the traditional health prevention campaigns, as well as to transform that reality in regard to perceptions, knowledge and behaviours of this population. To achieve our research objectives some questions were addressed: What teachers and students really know about cancer and prevention?; What are the best strategies and formats to improve cancer literacy and promote the adoption of preventive attitudes and behaviours?; Is this model appropriate to reach social change regarding cancer prevention? Our model is based on a *ripple effect*, as shown in Figure 1.1, where the different elements (teachers, students and other elements of the school community) actively interact with each other. In the larger circle are all the individuals that were involved in the project, namely members of the school community and even in some cases families and other members of the local community. Regarding health communication, we can describe this model as using health campaigns (the prevention projects developed by teachers), one of the issues analysed in health communication research [18].

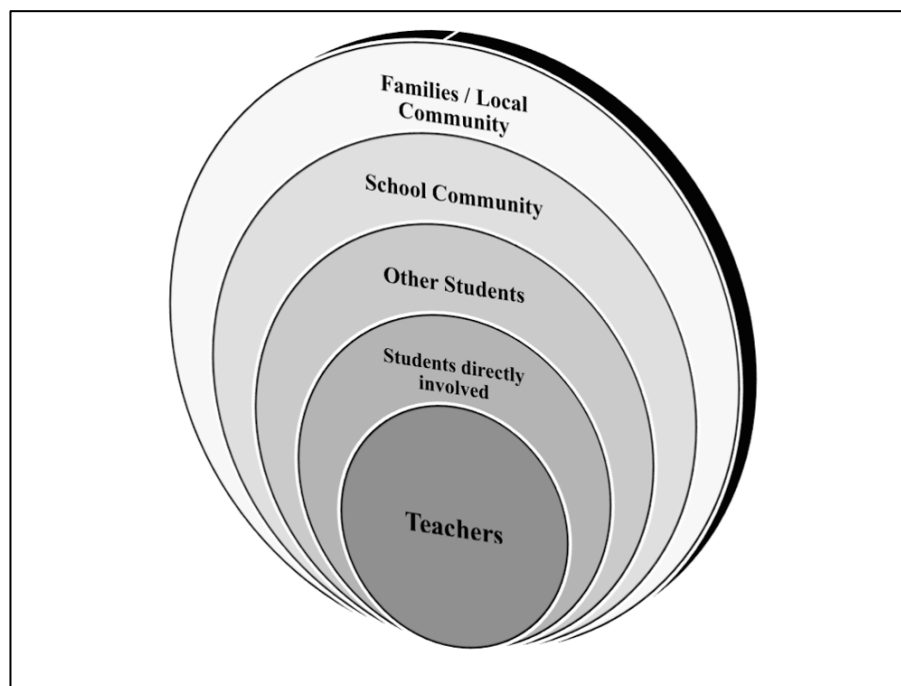


Fig. 1.1 – “Cancer, Educate to Prevent” – The ripple effect of the project implementation.

This model, as described above, has as bottom line the training program for biology teachers. During the training program teachers were skilled to actively contribute to develop and implement their own prevention campaigns focused on students and local communities. The project structure encompasses two distinct components: educational (different educational modules of the training program ranging from cancer biology to prevention campaigns design) and interventional (involving the design and implementation of prevention campaigns by teachers at school). Teachers' perceptions and knowledge about cancer and prevention were assessed in three phases, with questionnaires: i) at the beginning of the training program (pre-test), ii) immediately after the end of the training program (post-test) and iii) one year after the training program (follow-up). The training program itself was fully assessed, as well as other characteristics that endorsed the teachers' profile (training, career and socio-demographic characteristics) [1].

In order to answer the questions that justify this project (see previous section), the whole training program focused on teachers was scrutinized through the systematic presence of the field researcher. Moreover, the impact of this training program, specifically the projects that the teachers developed in their schools, were monitored and evaluated through systematic field attendance and the assessment of the students' knowledge and perceptions about cancer were surveyed in three different moments: i) before the implementation of the cancer prevention campaigns (pre-test), ii) immediately after (post-test) and iii) one year after the intervention (follow-up). Attitudes, behaviours and motivation towards school and health were assessed, as well as socio-demographic characteristics of the students, and their representations on cancer. A complex observational protocol has been undertaken, given our main goal: endorsing positive, conscious, durable and widespread changes toward health awareness, specifically on cancer.

The questionnaires applied to the students (experimental group) in those three moments of evaluation were applied to two control groups as well: 1) Internal control - students from schools where the projects were implemented (experimental schools), but from classes taught by teachers not involved in the program, and 2) External control – students from schools not involved in the program.

This project comprised an in-depth research and intervention that necessarily carried with it a complex process of monitoring and evaluation, as well as the participation of active mediators, the teachers with their own interventions at schools.

Last but not least, our pilot study also evidenced the importance of multidisciplinary teams: considering cancer as a whole, i.e., not only in its biological and clinical dimensions, but also as a social and cultural phenomenon, is definitely a condition for knowledge and action [18,

6]. So it was necessary to work with a multidisciplinary team, since it is a boundary project that needs specific knowledge from different fields of knowledge: Cancer research, Education, Sociology, Biology and Statistics.

Our research protocol included a threefold monitoring and evaluation process: on teachers, on students and on the implementation of the teachers' own projects. In this sense, it is a quasi-experimental study [12], aiming to understand a reality shaped by the traditional health prevention campaigns, as well as to transform that same reality (in the perceptions and behaviours of the targets), a semi-participatory action research [8]. This justifies our triangulated methodology and combining quantitative and qualitative techniques and procedures, in a mixed methods approach [4]. In addition to the questionnaires, with open and closed-ended questions [9], direct observation was systematic all along the study (from the training program to the implementation of the intervention projects developed by teachers). Photography and video were used in selected moments, and were valuable tools in order to produce complementary analytical data. A field diary with notes and questions was also an important tool to build a map of this complex process with the purpose of coordinate all the available field information.

Informal interviews and casual conversations were also important, especially in which concerns to teachers opinions about the easiness or the difficulties in applying their projects and the feedback of the students and other participants in this study. A more informal way of contacting participants (teachers and students), provided by fieldwork, allows an easier identification and control of the reliability of the study. For this unique pilot project about the Portuguese reality on cancer, we assumed from the very beginning that the population involved in the project was important in order to understand cultural and social implications on the attitudes and behaviours within this population, related to cancer prevention. Besides the implementation of this broad and complex methodological strategy was only possible due to the researchers involvement in the project, especially through the time that was spent on the field, not only gathering the data but also actively interacting in order to engage the schools in the project.

Figure 1.2 illustrates the combination of the strategies used in this model and the timeline for data collection.

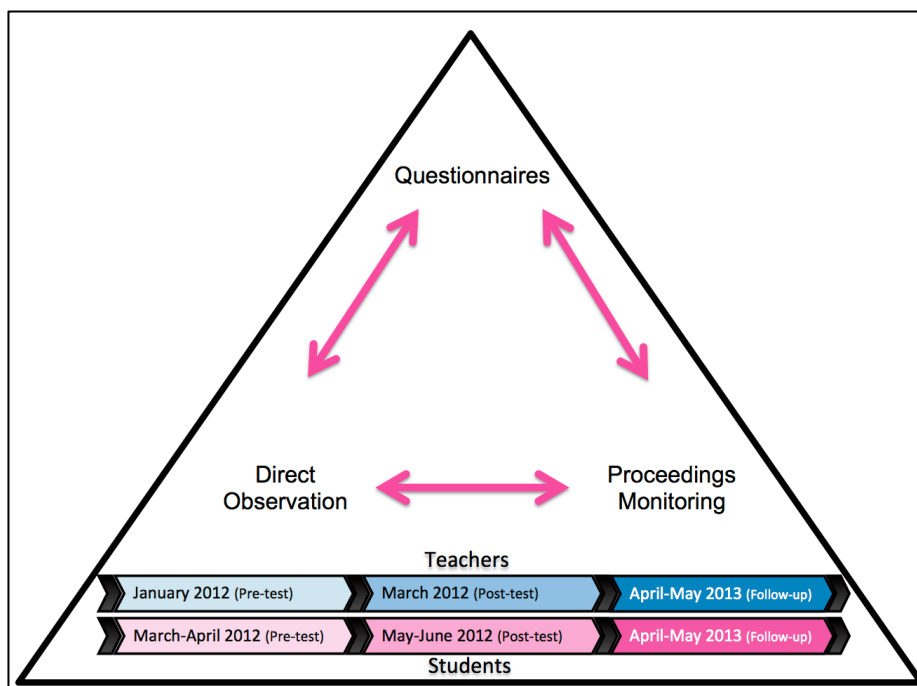


Fig. 1.2 - Methodology strategy and evaluation timeline.

The analysis also includes a matching between socio-demographic characteristics (e.g. grade, age, gender, family history) as well as attitudes and behaviours of the students. Self-perceptions and knowledge about cancer and prevention were also evaluated regarding the characteristics of these different individuals/groups for teachers and students as well.

Project Implementation

The whole project involved a protocol of systematic monitoring in order to review and, in the future, optimize and replicate/adapt this model to other groups and contexts.

The training program was developed regarding specific contents, with scientific and pedagogical approval of the Portuguese Ministry of Education and Science. Teachers were voluntarily enrolled and the training program was successfully implemented, only with a dropout rate of 12.9% (8 out of 62). The 54 teachers that completed the training program implemented their cancer prevention projects in 42 schools of the north and centre region of Portugal, directly involving 1,648 students from 82 classes and approximately 5,000 members of school communities, including in some cases students families. Each teacher designed and implemented its own prevention project regarding a specific cancer type and adapted to their school and its unique context. A wide range of formats were produced and in some cases not only for their students but also for the entire school community, families and local community [1].

As referred, three groups of students participated on the evaluation process in order to determine the success of this intervention. The experimental group was randomly selected - by cluster sampling - 21 of the classes that participated in the prevention projects were included in this group (a total of 493 students out of 1,648), according to the following inclusion criteria: classes from public schools attending to the 8th, 10th or 11th grade - in order to ensure a 1 year follow-up (9th and 12th grade students' conclude a study cycle and might move to a different school).

Besides, the number of classes selected from each geographic region was defined accordingly to its demographic density. After defining the experimental group we selected another 21 classes (a total of 426 students) to include in the internal control group.

Finally, for the external control group, 13 classes, with a total of 298 students, were selected according to the same inclusion criteria defined to the experimental group, from the same regions (specifically from the same districts), with similar social, economic and demographic characteristics in terms of context, and without any kind of participation in this project (teachers of these schools were not involved in the training program).

Schools from the north and centre region of Portugal, in total of 25, were involved in the study according to the criteria described above, with a total of 1,217 students in phase I, 986 in phase II and 676 in phase III. Table 1.1 summarizes the number of students from the different groups that participated in the study in the three phases and their distribution by

grade, gender if they deal or not with a cancer situation and with who, and what is the education level of their parents.

Regarding Table 1.1 in a general way, it can be referred that the sample is well balanced in terms of the number of students per grade, with an exception for the external control groups where the differences are higher. In terms of gender the sample has a slightly superior number of female students concerning the different phases and groups.

Between phase II and III the number of students that dealt with a cancer situation is homogenous in the different groups. At last, in which concerns to parents education, it is similar for mother and father and the mode is almost always on 6th grade (middle school), except for the external control group (see Table 1.1) with the 9th grade being the mode for fathers.

Table 1.1 - Sample main characterization by phase and group.

	Phase I (Pre-Test)						Phase II (Post-Test)						Phase III (Follow-Up)					
	Experimental			Internal control			Experimental			Internal control			Experimental			Internal control		
	N	%		N	%		N	%		N	%		N	%		N	%	
Grade																		
8 th	159	32.3		150	35.2		106	26.8		105	30.2		66	33.5		76	30.4	
10 th (Phase II) / 11 th (Phase III)	169	34.2		142	33.3		137	34.7		112	32.3		75	38.1		101	40.4	
11 th (Phase II) / 12 th (Phase III)	165	33.5		134	31.5		152	38.5		130	37.5		56	28.4		73	29.2	
Total %	493	100		426	100		395	100		347	100		197	100		250	100	
Gender																		
Male	233	47.3		179	42.1		182	46.1		149	42.9		81	41.1		108	43.2	
Female	257	52.1		246	57.7		213	53.9		197	56.8		114	57.9		136	54.4	
Missing data	3	0.6		1	0.2		---	---		1	0.3		2	1.0		6	2.4	
Total %	493	100		426	100		395	100		347	100		197	100		250	100	
Dealt with a cancer situation																		
Yes	176	44.6		174	50.1		176	44.6		174	50.1		81	41.1		127	50.8	
No	219	55.4		172	49.6		219	55.4		172	49.6		115	58.4		123	49.2	
Missing data	---	---		---	---		---	---		---	---		1	0.5		---	---	
Total %	395	100		347	100		395	100		347	100		197	100		250	100	
Dealt with a cancer situation with...																		
With a friend	18	10.2		22	12.7		18	10.2		22	12.7		5	6.2		15	11.8	
With a relative	149	84.7		141	81.0		149	84.7		141	81.0		69	85.1		102	80.3	
With you	---	---		---	---		---	---		---	---		---	---		---	---	
With another person	8	4.5		9	5.2		8	4.5		9	5.2		3	3.7		8	6.3	
With a friend and a relative	---	---		---	---		---	---		---	---		---	---		---	---	
With a relative and another person	---	---		---	---		---	---		---	---		---	---		---	---	
Missing Data	1	0.6		---	---		1	0.6		---	---		---	---		---	---	
Total %	176	100		174	100		176	100		174	100		81	100		127	100	
Mother Education																		
No grade	5	1.3		2	0.6		5	1.3		2	0.6		---	---		---	---	
4 th grade	51	12.9		60	17.3		51	12.9		60	17.3		---	---		---	---	
6 th grade	90	22.8		77	22.2		90	22.8		77	22.2		---	---		---	---	
9 th grade	75	19.0		77	22.2		75	19.0		77	22.2		---	---		---	---	
12 th grade	73	18.5		70	20.1		73	18.5		70	20.1		---	---		---	---	
Higher education	72	18.2		36	10.4		72	18.2		36	10.4		---	---		---	---	
Missing data	29	7.3		25	7.2		29	7.3		25	7.2		---	---		---	---	
Total %	395	100		347	100		395	100		347	100		---	---		---	---	
Father Education																		
No grade	10	2.5		4	1.2		10	2.5		4	1.2		---	---		---	---	
4 th grade	56	14.2		44	12.7		56	14.2		44	12.7		---	---		---	---	
6 th grade	84	21.3		92	26.5		84	21.3		92	26.5		---	---		---	---	
9 th grade	76	19.2		51	14.7		76	19.2		51	14.7		---	---		---	---	
12 th grade	74	18.7		70	20.1		74	18.7		70	20.1		---	---		---	---	
Higher education	42	10.6		20	5.8		42	10.6		20	5.8		---	---		---	---	
Missing data	53	13.5		66	19.0		53	13.5		66	19.0		---	---		---	---	
Total %	395	100		347	100		395	100		347	100		---	---		---	---	

The dropout rate, i.e. the number of students that gave up the study between phase I and phase II, was 19.0% (n=231). Between phase II and phase III, there was no dropout, but rather a sub sample was built in order to reduce the fieldwork and keep it manageable with the resources available. So, from the initial 25 schools selected for the evaluation process, 13 were selected again, according to their representativeness in each geographic region represented (defined accordingly to its demographic density). Taking into account this sub sample the number of students was reduced in 31.4% (n=310) making manageable the evaluation work in the field.

During all the implementation, the three evaluation moments, regarding self-perceptions, knowledge and other characteristics of the individuals that are part of the study were conducted in order to determine the impact and success of this model.

Furthermore, the notes taken from the fieldwork (essentially from the application of the questionnaires and the monitoring of the implementation of some of the teachers cancer prevention projects) and the informal interviews with teachers and students revealed a positive feedback of the respondents toward this initiative.

Another important issue should also be emphasized, regarding the school boards that, even with all of the contingencies, were, in most of the cases, always very receptive and helpful with the implementation of this initiative. The preliminary results of the impact of this model are very promising concerning to its replication, still procedures to adapt the initial protocol should be done for shorter actions and/or wider scopes.

Reflections and Future Lines of Research

Our research emphasizes the potential that schools have on socialization, then on health, especially in cancer prevention education.

Teachers are directly involved with the students, familiar with school environment and are undoubtedly the privileged mediators to promote new values toward their students. Schools are the core and the right environment for social change.

The complexity of the methodology strategy used in this research allowed the evaluation and monitoring of the entire process in order to determine its success. The training program was designed and implemented with teachers. They were able to design and adapt their cancer prevention interventions to their own context, which can effectively contribute to increase the potential spread effect. Through teachers, our project will target students and spread to families, addressing the problem of cancer prevention on a social context.

So far, the implementation of this pilot study demonstrated that this is a feasible model, based on early, in-depth interventions, tailored and targeted for specific populations. The model also shows the importance of multidisciplinary teams to put on practice a model with a high level of complexity.

As a quasi-experimental research, this study allows us to define future lines of research: a) evaluate whether the training model is transposable to teachers with other academic backgrounds (e.g. arts); b) evaluate the effectiveness of the training model for other diseases (e.g. obesity, diabetes); c) evaluate if the model is nationwide scalable and assess the spread effect of these campaigns; d) evaluate the impact on families as part of the process of the information dissemination; and finally e) evaluate the transposition of this model to other social and cultural contexts (countries or specific social groups) preserving the necessary adaptations.

In sum, the idea that health campaigns should be tailored and targeted is a reality evidenced in this study. Each school (our privileged environment for social change) is a particular context, so prevention programs must be adapted to its specific characteristics. Besides, the characteristics of the participants and at the same time the targets of these campaigns must be included in order to understand and drive structural changes in practices, as well as in attitudes and representations towards cancer prevention as a community goal.

This model opens a new perspective for the development and validation of cancer prevention education strategies, based upon focused interventions in restricted targets (students) through non-health professionals (teachers) unlike the current leading model of

health prevention campaigns, that are based on general and undifferentiated actions mediated by health professionals, focused on the technical and scientific information and rather ineffective in its changing impact of symbolic, cognitive and practical relationship with the disease. Moreover, our model allows the hypothesis of future replication-adaptation in other targets for health education, such as social groups with particular characteristics (immigrants, deprived communities), through oriented and specialized mediation (for example, social workers).

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Chapter 2

“An unexplored potential to reduce cancer burden of future generations - improving the low levels of cancer literacy among adolescents”

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Abstract

Background

Half of cancer related deaths are due to unhealthy behavioral options that could potentially be avoided by the individuals, highlighting the extreme importance of cancer literacy in improving population's health. Due to the behavior plasticity and social networking potential, adolescents are elective targets for behavior change towards cancer prevention.

In this research we evaluated the cancer literacy of a Portuguese population of adolescents, addressing the dimensions of self-perceptions and knowledge about cancer and its prevention.

Methods

A survey was applied to a sample of 1,217 middle/high school students in order to determine the levels of cancer literacy regarding six topics: cervical, breast, skin and colorectal cancer, cancer prevention and cancer risk factors.

Results

The results of this study revealed an overall medium/low level of cancer literacy among the participants. Average perceptions on cancer topics ranges from 28% (on Colorectal Cancer) to 60% (on Prevention) and there are another two topics above 50% (Breast Cancer and Risk Factors). For cancer knowledge the topics ranges from 26% (on Colorectal Cancer) to 59% (on Skin Cancer) and there are only two topics with average knowledge values above 50% (Skin and Breast Cancer). When comparing global values, students significantly know more than they perceive. Comparing students' perceptions and knowledge girls have significantly higher perceptions and knowledge than boys for several cancer topics and in global assessment. Also school-grade is determinant for the perception and knowledge levels in most of the topics, with 11th grade students having a significantly higher perceptions and knowledge levels than 10th and 8th grade students.

Conclusions

The results of this study revealed an overall medium/low level of cancer literacy and for some cancer types (cervix, breast, skin) a lack of connection between screening/prevention items and perceptions about the disease.

Perceptions and knowledge about cancer topics depend on gender and school-grade of the inquiries, thus profiling of target population is mandatory to design, target and adapt cancer education campaigns.

Our results suggest that adolescents hold enormous potential to improve their cancer literacy levels and consequently reduce the cancer burden of future generations.

Background

One of the most important topics in health literacy research is health education communication and its impact on behaviors related to disease prevention (i.e. the more effective means by which researchers can help improve citizens health literacy levels in order to prevent diseases like diabetes, obesity or cancer).

On health literacy field, cancer assumes a relevant role due to its increasing incidence and mortality [1-4] and the profound impact of this disease on society. Cancer literacy is a major focus of new policies and strategies based upon cancer prevention education that aim to reduce the burden of cancer for future generations [5].

The first attempt to elaborate an operational definition for cancer literacy refers to it as *all the knowledge a layperson needs to possess to understand the information and advice the health system has to offer with regard to preventing, diagnosing and treating cancer*.

A cancer literate person should be more able to seek *preventive medical checkups and be susceptible to well-founded advice on disease prevention*, which is a crucial issue for public health resources management [5].

Regarding cancer context, prevention is a determinant topic to reduce cancer incidence and mortality since it is known that half of the deaths attributed to cancer can be avoided [6] so it is vital to make people aware of effective cancer prevention strategies. Increasing knowledge about cancer is a crucial point but does not guarantee the adoption of preventive behaviors. Action, in the way that skills are mobilized to translate knowledge, is also needed in order to raise cancer awareness [7]. Knowledge is also related to the information need and education level. Individuals with a low educational level need more health information to get the necessary knowledge that makes them health literate [8]. This can only be achieved with a closest collaboration between researchers and healthcare professionals and their ability to communicate with individuals about their health status [9, 10].

Cancer literacy has a major importance not only for patients that have to decide upon the information given in the healthcare services, but for all of us, as individuals that can effectively do something towards health promotion and disease prevention and not be dependent of others.

Assessing cancer literacy levels on populations is thus a priority since it could have serious implications to an individual's quality of life, especially in what concerns cancer prevention: risk behaviors, participation in cancer screenings and stage diagnosis.

As far as the authors know, there are few instruments available to measure cancer literacy in different aspects of the cancer spectrum. One of these instruments is the *CASE-Cancer* –

the Communication and Attitudinal Self-Efficacy scale. Due to cancer burden, particularly in patients and their caregivers, instruments like the CASE-Cancer scale attempt to measure the self-efficacy of patients in which concerns to productive communication and positive attitude towards cancer. This tool emphasizes the communication network established between patients and healthcare providers once the patients' attitudes and healthcare providers' expectations might influence this flow [11].

Another instrument is the *CLS – the Cancer Literacy Score* – developed by European researchers that integrate an important attempt to define cancer literacy in the European context. These authors define cancer literacy as *all the knowledge a layperson needs to possess to understand the information and advice the health system has to offer with regard to preventing, diagnosing and treating cancer* [12].

The *CMLT – Cancer Message Literacy Test* – is a pair of tools that contains the *CMLT-Listening* (CMLT-L) and the *CMLT-Reading* (CMLT-R). These tests use messages that simulate real situations of adults' everyday life and allow the establishment of a link between spoken/oral and written/print literacy and the influence of this link in healthcare decision-making and health behavior [13, 14].

These tools cover a wide range of dimensions of cancer literacy, but none of them tests topics related to cancer prevention. According to Koay et al. [15], new tools are needed and new studies are required to improve the existing tools, particularly in what concerns to cancer prevention.

In our study we built a new instrument to assess cancer literacy (perceptions and knowledge) in a population of adolescents, considering a wide range of cancer topics, including risk factors and cancer prevention.

We focused on this specific population (adolescents) because: 1) they are in the age of active learning, under the influence of diverse experiences and social agents (for example at school); 2) adolescence is a stage of transition between childhood and adulthood and this stage of development of new cognitive skills, for the construction of an identity and the acquisition of psychological sense of control over their lives, their actions and attitudes developing a lifelong system of ethical and moral values [16]; 3) as a phase of transformation, it will be easier to see a change in their attitudes and behavior in relation to the lifestyle that should be adopted to promote the prevention of diseases such as cancer; and 4) young people have the capacity of mutual influence, when adopting particular lifestyles in regard to risk behavior. This particular group has a great potential to develop skills and improve cancer literacy together with a dissemination potential (social networking) that might be critical to amplify the impact of future targeted educational campaigns.

Our study showed that cancer literacy levels are medium/low among adolescents, which opens an opportunity to design, adapt and target future campaigns/messages to this population.

Methods

The target of this study, are school-age adolescents that already have the functional literacy skills, such as reading and writing. Besides that they are not cancer patients, so the information that is more relevant for them is about prevention and risk factors knowledge. This study involved a total of 1,217 students, between 13 and 20 years old, from 25 schools of Portuguese North and Center regions. These schools and students were selected from the 8th, 10th and 11th grade classes that participated in that program (see details in Barros et al., 2014) [17].

In order to measure students' perceptions and knowledge about cancer, we created the "Students Knowledge about Cancer" questionnaire (see Additional File 1), which was designed by a multidisciplinary team, including high school teachers and several cancer experts.

This instrument is focused on four types of cancer with higher incidence and mortality among Portuguese population: cervical, breast, skin and colorectal cancer [18], its risk factors and prevention. Each topic referred above is composed by a set of items that are part of a main theme (cervical, breast, skin and colorectal cancer, risk factors and, prevention).

We applied a pilot-test version questionnaire on a group of 10 students, to tune up the instrument. The final version includes 35 items organized in three sections: 1) Perceptions about cancer (13 items); 2) Knowledge about cancer (18 items); and 3) Students' socio-biographic characterization (4 items). The questionnaire presented a good measure of internal reliability (Cronbach's Alfa = 0.734).

The Portuguese Ministry of Education and Science approved the study. All the participants, in this case the parents or tutors of the students have provided their written informed consent to participate in the study before the application of the questionnaire to the students under 18 years old. For those between ages 13 and 18 years old the consent was sought from their parents. We applied the questionnaires in a classroom environment, in paper format, at the 25 schools, during March and April 2012. Data from surveys were analyzed using IBM® SPSS® Statistics, version 22.

Distribution analysis showed that these variables couldn't be considered normally distributed. Thus, we opted for the use of nonparametric tests (*Related-Samples Friedman's Two-Way Analysis of Variance by Ranks*, *Related-Samples Wilcoxon Signed Rank Test*, *Independent-Samples Mann-Whitney U Test* and *Independent-Samples Kruskal-Wallis Test*).

Results

Sample characterization

Most of the students – 92.5% (1,126) – are from Portuguese North region schools, and 7.5% (91) are from Center region schools. The sample is well balanced by gender, with 54.1% (659) girls and 45.5% (554) boys. The mean age is 15 years old; 31.1% (378) are attending middle school (8th grade), while 68.8% (838) are attending high school (10th and 11th grade). Detailed information is available on Additional Files (see Additional File 2 – Students' characterization).

Cancer Literacy

Perceptions About Cancer (by item)

On Table 2.1 we present students' perceptions (perceived knowledge) on 13 items about cancer, expressed in a scale from 0 (*I know nothing/I don't have any information*) to 10 (*I know almost everything/I have enough information*).

Table 2.1 – Students' perceptions about cancer items (n=1217).

Self-perception	0-1		2-3		4-6		7-8		9-10	
	N	%	N	%	N	%	N	%	N	%
Cervical Cancer	112	9.2	175	14.3	643	52.9	220	18.1	66	5.5
Breast Cancer	68	5.6	115	9.4	644	53.1	290	23.9	95	7.8
Colorectal Cancer	496	41.2	286	23.7	329	27.3	62	5.1	31	2.6
Cancer Prevention	74	6.2	115	9.6	467	38.8	350	29.2	196	16.3
Risk Factors	85	7.1	145	12.1	473	39.5	320	26.7	176	14.7
HPV	627	52.3	145	12.1	242	20.2	110	9.2	75	6.2
Pap smear Test	326	27.0	152	12.5	360	29.8	234	19.3	137	11.3
UV Radiation	125	10.4	97	8.1	382	31.8	334	27.7	264	22.0
Melanoma	596	49.6	154	12.8	263	21.9	129	10.7	59	4.9
Skin Self-exam	411	34.5	245	20.5	363	30.5	120	10.0	54	4.5
Mammography	88	7.4	120	10.0	469	39.3	290	24.3	229	19.1
Colonoscopy	561	46.3	151	12.5	289	23.8	120	10.0	89	7.4
Hereditary Cancer	269	22.2	133	11.0	393	32.4	232	19.1	186	15.3

The first main result to point out is that the rate of students with the perception of *knowing almost everything* on each item is usually the lowest. On items related to Colorectal Cancer, HPV, Melanoma, Skin Self-exam and Colonoscopy, students with the perception of *knowing nothing* or *almost nothing* get the highest rates. On Cervical and Breast Cancer, students'

perceptions get mostly concentrated at the middle of the scale (*I know more or less*). On items related to Cancer Prevention, Risk Factors, UV Radiation and Mammography, students' perceptions range from middle to middle-high values. On Pap Smear Test and Hereditary Cancer, students' perceptions get mostly at the middle of the scale, but highly scattered across *knowing nothing* to *knowing almost everything*.

Comparing students' perceptions on some cancer types we found a lack of connection between screening/prevention items and the disease. On Cervical Cancer, 52.9% (643) of the students stated to *know more or less* about the item. However, 52.3% (627) have the perception of *knowing nothing* on HPV and 39.5% have the perception of *knowing nothing* or *almost nothing* on Pap Smear Test (although 29.8% get at the middle of the scale). On Breast Cancer, 53.1% (644) stated to *know more or less* about the item, but 43.4% (519) claim to *know more* on Mammography. On skin cancer, 81.5% (980) of the students stated to *know more or less* or *know more* about UV Radiation, but 49.6% (596) claims to *know nothing* on Melanoma, and 55.0% (656) stated to *know nothing* or *almost nothing* on Skin Self-exam.

Opposing to the above, students' perceptions on Colorectal Cancer and Colonoscopy showed to be consistent. In fact, 41.2% (496) stated to *know nothing* on Colorectal Cancer and 46.3% (561) claimed to *know nothing* on Colonoscopy.

Students have identical perceptions on Cancer Prevention and Risk Factors. On the first, 38.8% (467) claim to *know more or less* about the item and 45.5% (546) have the perception of *knowing more than the average*. On the last, 39.5% (473) claim to *know more or less* about the item and 41.4% (496) have the perception of *knowing more than the average*.

Knowledge About Cancer (by item)

On Table 2.2 we present students' (effective) knowledge on 16 items about cancer.

Table 2.2 – Students' knowledge about cancer items (n=1217).

Knowledge	Correct Answer			Incorrect answer			Don't Know No Answer		
Questions	N	%		N	%		N	%	
Agent that causes cervical cancer	367	30.2	HPV	81	6.7	<i>H. pylori</i>	37	2.2	HIV
Behavior that increase the risk of infection by HPV	389	32.0	Having multiple sexual partners	336	27.6	<i>Pseudomonas</i>	34	2.8	Using oral contraceptives
Type of cancer that can be prevented using a vaccine	974	80.0	Cervical Cancer	44	3.6	Colorectal Cancer	40	3.3	Breast Cancer
The pap smear test indicates	610	50.1	Changes in cervical cells	146	12.0	Polyps	51	4.2	Dysplastic moles
Main cause of the most cases of skin cancer	953	78.3	Too much exposure to sunlight	132	10.8	Hereditary mutations	27	2.2	Excessive production of vitamin D
Breast cancer affects	931	76.5	Mainly women	264	21.7	Mainly men	1	0.1	Only men
Screening test for breast cancer	1131	92.9	Mammography	20	1.6	Citology	10	0.8	Endoscopy
Period of the day when exposure to the sun is more dangerous	1095	90.0	11-17h	55	4.5	16-18h	41	3.4	7-10h
Which of the following group may be at risk of developing skin cancer	447	36.7	All the options mentioned	408	33.5	People with fair skin	207	17.0	People with dark skin
Most deadly cancer for women in the world	536	44.0	Breast Cancer	365	30.0	Cervical Cancer	42	3.5	Skin Cancer
Measures to decrease the risk of women to develop breast cancer	123	10.1	Decrease alcohol consumption	275	22.6	Increase calories consumption	52	4.3	Decrease the number of sexual partners
Screening test for colorectal cancer	784	64.4	Colonoscopy	26	2.1	Citology	19	1.6	Mammography
There is a higher chance of developing a colorectal cancer	166	13.6	If there are other cases in the family	183	15.0	If you have a diet low in fat and red meat	69	5.7	If female
Measures to decrease the risk of women to develop colorectal cancer	146	12.0	Practice physical exercise regularly	144	11.8	Decrease salt consumption	84	6.9	Increase the consumption of calories
Most deadly cancer in Portugal	171	14.1	Colorectal Cancer	397	32.6	Cervical Cancer	171	14.1	Skin Cancer
Most deadly type of skin cancer	394	32.4	Melanoma	38	3.1	Basal cell carcinoma	21	1.7	Sarcoma

We show the rate of correct answers in each item and the distribution of students' answers among the multiple response options, in order to identify eventual misconceptions.

Only seven of these items have a rate of correct answers above 50%: 1) the *"screening test of breast cancer"* (93%; 1131); 2) the *"most dangerous period of the day to sun exposure"* (90%; 1095); 3) the *"type of cancer that can be prevented using a vaccine"* (80%; 974); 4) the *"main cause of the most of skin cancer"* (78%; 953); 5) *"who is affected by breast cancer"* (77%; 931); 6) the *"screening test for colorectal cancer"* (64%; 784); and 7) *"the Pap Smear Test"* (50%; 610). The only relevant misconception among these items is related to *"who is affected by breast cancer"*, in which 22% (264) of the students considered that breast cancer *"only affects women"*.

On the item related to the *"most deadly cancer for women in the world"*, 44% (536) of the students answered correctly and 21% (253) *didn't know* or *didn't answer*. Nevertheless, 30% (365) considered that *"cervical cancer"* was the correct answer, showing an important misconception on this item.

Four other items have a rate of correct answers ranging from 30 to 40%: 1) the *"risk groups to develop skin cancer"* (37%; 447); 2) the *"most deadly type of skin cancer"* (32%; 394); 3) the *"behavior that increases the risk of infection by HPV"* (32%; 389); and 4) the *"agent that causes cervical cancer"* (30%; 367). We identified two relevant misconceptions among these items: one related to *"risk groups to develop skin cancer"*, in which 34% (408) of the students considered only *"people with fair skin"*; and other related to the *"behavior that increases the risk of infection by HPV"*, in which 28% (336) considered *"sharing needles with infected people"*.

Four of the items have a rate of correct answers below 15%: 1) the *"most deadly cancer in Portugal"* (14%; 171); 2) the *"chance of developing a colorectal cancer"* (14%; 166); 3) the *"measures to decrease the risk of women to develop colorectal cancer"* (12%; 146); and 4) the *"measures to decrease the risk of women to develop breast cancer"* (10%; 123). The first one has the most relevant misconception, in which 33% (397) of the students considered the *"breast cancer"* as the *"most deadly cancer in Portugal"*. On the other three items, most of the students *didn't know* or *didn't answer*. Nevertheless, 23% (275) considered the *"decrease of the use of antiperspirants"* as the most important *"measure to decrease the risk of women to develop breast cancer"* and 15% (183) considered that the *"infection with H. pylori"* increases the *"chance of developing a colorectal cancer"*.

Perceptions About Cancer (by topic)

On Table 2.3 we present the mean values (in %) and standard deviations (SD) of students' perceptions and knowledge on six topics about cancer – joining cancer items in broader themes. We also present global perception and global knowledge.

Table 2.3 - Students' perceptions and knowledge about cancer topics.

	Perception		Knowledge		Dif. ^a	p-value ^b
	Mean (%)	SD	Mean (%)	SD		
Cervical Cancer	39.9	22.5	48.1	30.3	8.2	<0.001
Skin Cancer	40.4	22.6	59.3	23.0	18.9	<0.001
Breast Cancer	57.2	21.6	55.9	20.2	-1.3	0.074
Colorectal Cancer	28.4	24.6	26.0	21.9	-2.3	0.002
Risk Factors	57.4	25.3	33.0	19.1	-24.4	<0.001
Prevention	59.8	24.5	49.2	16.6	-10.6	<0.001
Global^c	44.4	17.6	47.3	15.2	2.9	<0.001

^a Mean differences (*Knowledge-Perception*).

^b Related-Samples Wilcoxon Signed Rank Test.

^c Overall weighted mean (according to the number of items in each topic).

Students have mean perception values over 50% on topics related to Prevention (59.8%), Risk Factors (57.4%) and Breast Cancer (57.2%). Two topics have mean values approximately between 40 and 50% - Skin Cancer (40.4%) and Cervical Cancer (39.9%) – and one topic below 30% - Colorectal Cancer (28.4%). The mean value for Global Perception is 44.4%.

We also compare students' perceptions on these six topics (see Additional File 3). According to the *Related-Samples Friedman's Two-Way Analysis of Variance by Ranks*, we conclude that the difference among these topics is statistically significant ($p < 0.001$). Pairwise analysis shows three distinct levels on students' perceptions: 1) the *lower level*, on Colorectal Cancer, which is significantly lower than all the other topics (all the p-values < 0.001); 2) the *middle level*, with identical perceptions on Skin and Cervical Cancer ($p = 1.000$); and 3) the *higher level*, with identical perceptions on Breast Cancer, Risk Factors and Prevention (all p-values > 0.05).

Knowledge About Cancer (by topic)

Students have mean knowledge values over 50% on topics related to Skin Cancer (59.3%) and Breast Cancer (55.9%). Two topics have mean values slightly below 50% - Prevention (49.2%) and Cervical Cancer (48.1%) – and two other topics below 40% - Risk Factors (33.0%) and Colorectal Cancer (26.0%). The mean value for Global Knowledge is 47.3%.

Students' knowledge was also compared on these six topics (see Additional File 3 – Topics comparison on Perceptions and Knowledge about cancer). According to the *Related-Samples Friedman's Two-Way Analysis of Variance by Ranks*, we conclude that the difference among these topics is statistically significant ($p < 0.001$). Pairwise analysis shows identical levels of students' knowledge on Colorectal Cancer and Risk Factors ($p = 1.000$) and these levels are significantly lower than all the other topics (all the p -values < 0.001). The other four topics are significantly different from each other (all the p -values < 0.001). Nevertheless, we can still distinguish three levels on students' knowledge: 1) the *lower level*, on Colorectal Cancer and Risk Factors; 2) the *middle level*, on Cervical Cancer and Prevention; and 3) the *higher level*, on Breast Cancer and Skin Cancer.

Comparing Students' Perceptions to Student's Knowledge

On Table 2.3 we present the mean differences between knowledge and Perceptions on each topic. There are two topics in which students know significantly more than they perceive: Cervical Cancer (with a difference of 8.2%; $p < 0.001$) and Skin Cancer (with a difference of 18.9%; $p < 0.001$). On the contrary, there are three topics in which students know significantly less than they perceive: Colorectal Cancer (with a difference of -2.3%; $p = 0.002$), Risk Factors (with a difference of -24.4%; $p < 0.001$) and Prevention (with a difference of -10.6%; $p < 0.001$). On Breast Cancer, students' have identical values on perceptions and knowledge (with a difference of -1.3%; $p = 0.074$). When comparing global values, students significantly know more than they perceive ($p < 0.001$), although the mean difference is only 2.9%.

Comparing Students' Perceptions and knowledge by Gender and School-grade

On Figure 2.1 we present students' perceptions and knowledge by gender.

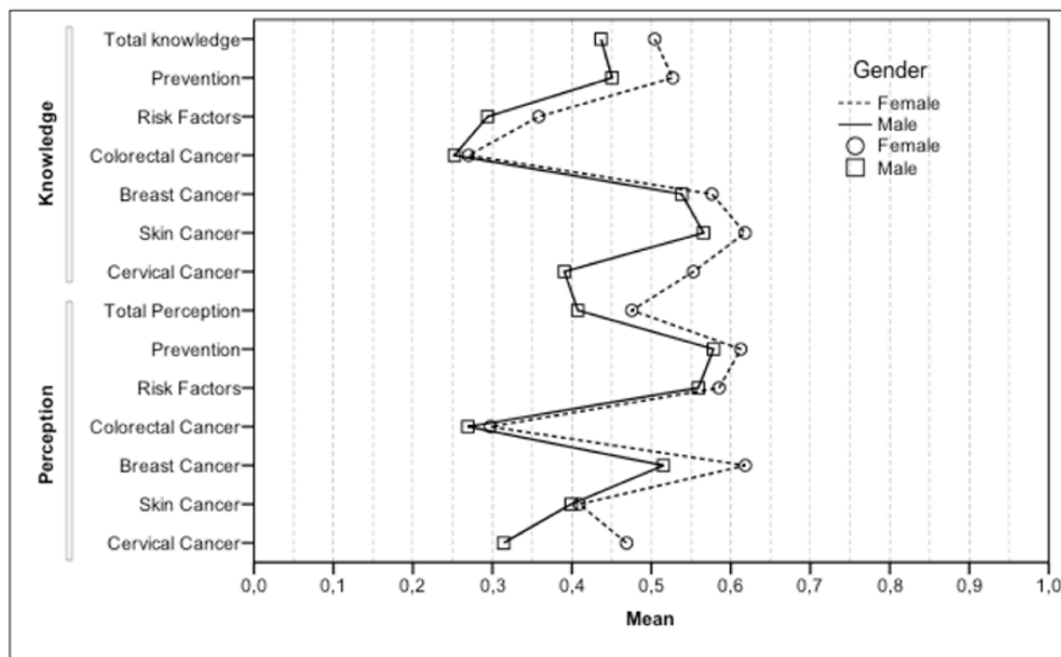


Fig. 2.1 – Students' perceptions and knowledge about cancer topics by gender.

According to the *Independent-samples Mann-Whitney U Test*, boys and girls have identical perceptions on Skin Cancer ($p=0.571$), Colorectal Cancer ($p=0.108$) and Risk Factors ($p=0.087$), and identical knowledge on Colorectal Cancer ($p=0.264$). On the other topics, and on global assessment, girls have significantly higher perceptions and knowledge than boys (all p -values < 0.05).

On Figure 2.2 we also present students' perceptions and knowledge by school grade.

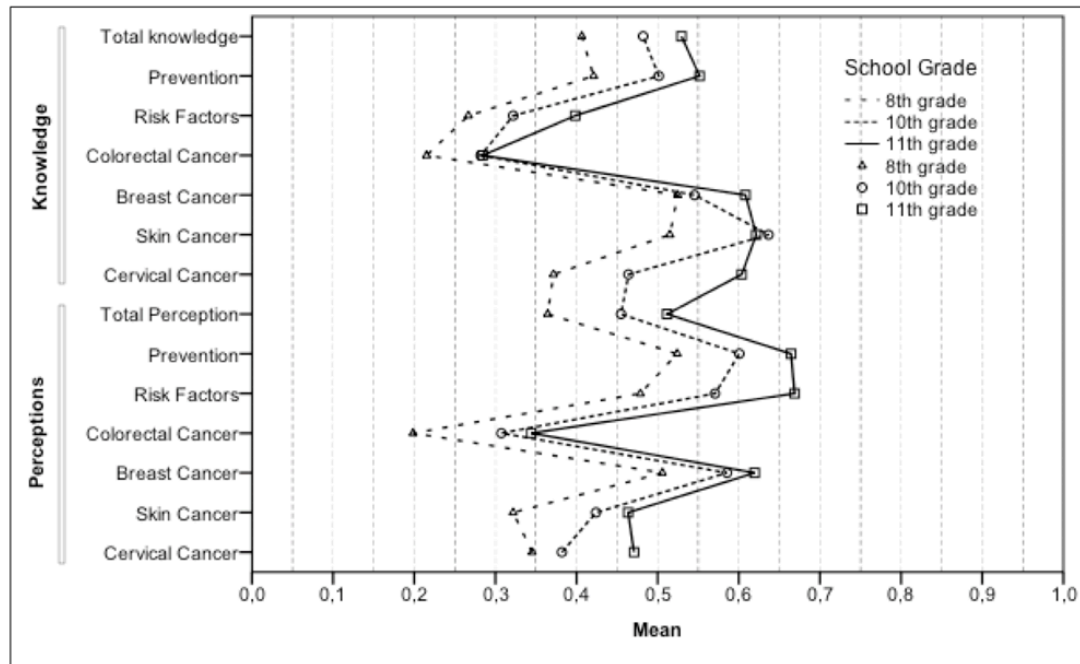


Fig. 2.2 – Students' perceptions and knowledge about cancer topics by school grade.

In most of the topics, 11th grade students have significantly higher perceptions and knowledge than 10th grade students, and 10th grade students have significantly higher perceptions and knowledge than 8th grade students (according to the Independent-samples Kruskal-Wallis Test, p -values ≤ 0.05).

Considering students' perceptions, the exceptions occur on topics related to Breast Cancer and Colorectal Cancer, in which 10th and 11th grade students have identical values ($p > 0.05$) and 8th grade students have lower values ($p < 0.05$); and on Cervix Cancer, in which 8th and 10th grade students have identical values ($p > 0.05$) and 11th grade students have higher values ($p < 0.05$).

On students' knowledge, the exceptions occur on topics related to Skin Cancer and Colorectal Cancer, in which 10th and 11th grade students have identical values ($p > 0.05$) and 8th grade students have lower values ($p \leq 0.05$); and on Breast Cancer in which 8th and 10th grade students have identical values ($p > 0.05$) and 11th grade students have higher values ($p \leq 0.05$).

Discussion

In this study we assess cancer literacy in Portuguese adolescents, considering both perceptions and knowledge.

We analyzed data collected with the *Students Knowledge about Cancer* questionnaire by items and cancer topics. Perception is higher for the items on topics: cancer prevention, risk factors, UV radiation and mammography (Table 2.1), while the sixteen questions related to effective knowledge showed that only seven items have more than 50% correct response rate and only 5 of these were above 75% (Table 2.2).

Average perceptions on cancer topics ranges from 28% (on Colorectal Cancer) to 60% (on Prevention) and there are another two topics above 50% (Breast Cancer and Risk Factors). For cancer knowledge the topics ranges from 26% (on Colorectal Cancer) to 59% (on Skin Cancer) and there are only two topics with average knowledge values above 50% (Skin and Breast Cancer) (Table 2.3).

When we compare students' perceptions and knowledge on the four types of cancer (cervical, breast, skin and colorectal cancer), Colorectal Cancer is the topic with the lowest results both on perceptions and knowledge, revealing high consistency. These results emphasize that although colorectal cancer has the highest mortality rate in Portugal, information about this cancer type is scarce and disregarded. The absence of an organized screening program promoted by the national health system and the few information campaigns promoted by a national association for colorectal cancer [19], also contributes for this reality.

On the other hand, Breast Cancer is the topic with higher positive results, both for perceptions and knowledge, being the knowledge average slightly higher than the perceptions average. These results might be explained by the fact that Breast Cancer is one of the cancers with higher visibility in media education campaigns [20]. Moreover there is a national organized program for breast cancer screening that results from a partnership between the Portuguese Ministry for Health and the Portuguese League Against Cancer [21] and there are several non-profit organizations that support breast cancer patients [22, 23].

Concerning cervical cancer, students have significantly higher levels of knowledge than perceptions, nevertheless both averages are below 50%. These results are unexpected, considering the information already available related to this topic. Since 2008, cervical cancer and Human Papilloma Virus (HPV), are the focus of sounding media campaigns promoting HPV vaccination [24, 25], especially for young girls, the target population of the national vaccination program against HPV. Additionally, the Portuguese schools have

mandatory Sexual Education programs [26], which also focus on the diseases that can be caused by sexual risk behaviors and in theory should address baseline literacy on cervix cancer.

Considering the Skin Cancer topic, students' perceptions and knowledge are significantly different, with the perceptions average below 50% and knowledge above that value. Most campaigns focusing this type of cancer are seasonal or short-term campaigns, during spring and summer, with a focus on sun exposure at the beach [27]. Thus, we can speculate that these results are probably related to the timing of the application of our questionnaire (we applied the questionnaire in the winter, what might found the adolescents in the lower levels of skin cancer awareness).

Students' knowledge and perceptions on Risk Factors and Prevention, together with the low levels of overall cancer literacy, are probably the results that stand out in our study. In these two topics, students have average perceptions above 50% and significantly lower levels on average knowledge (below 50%). In addition, the levels on risk factors are significantly lower than those on prevention. These findings suggest that students do not actually know as much as they believe to know about cancer prevention and risk factors. This false perception of knowledge may result from the idea that information related to these topics is just common sense. Complementing this idea with some of the results obtained for the knowledge questions it is possible to state that students are aware of the screening exams (secondary prevention) for the different types of cancer but do not know the causes or the risk factors (primary prevention), which may reflect the contents of the information campaigns that they have been exposed.

In Figure 2.3 we show the average levels of students' knowledge and perceptions on each of the six topics, and the relations among them.

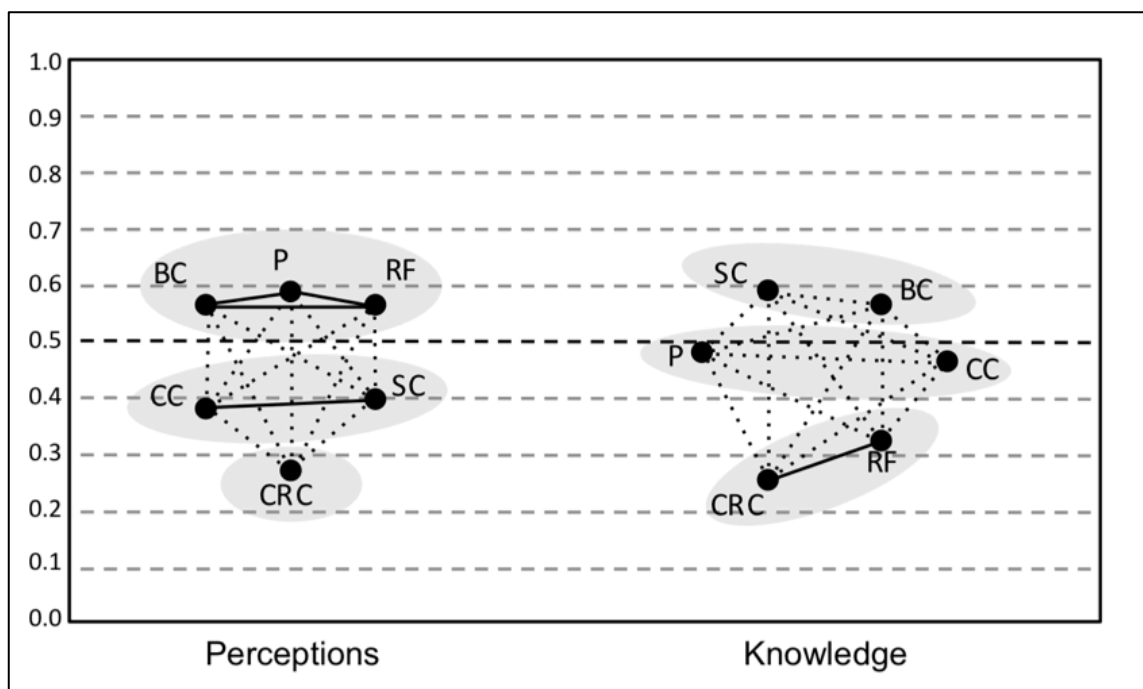


Fig. 2.3 – Students' perceptions and knowledge about cancer topics: visual discussion

BC – Breast Cancer; CC – Cervical Cancer; CRC – Colorectal Cancer; SC – Skin Cancer; P – Prevention; RF – Risk Factors. Bold lines connect cancer topics with identical levels of knowledge/perceptions, and dotted lines connect topics with statistically different levels of knowledge/perception.

The analysis by gender and school grade shows that females have significantly higher knowledge and perceptions than males, in most of the topics. There are also significant differences among grades. The younger students – 8th grade students – have the lowest average values on knowledge and perceptions in most of the topics. Except for skin cancer knowledge, perceptions and knowledge increases along with students' school grade. These results are probably associated to some of the contents of the school curricula that are linked to cancer knowledge and prevention [28, 29], but other socio-demographic factors might be involved. So far, no significant differences were found when we analyzed variables like parents education or contact with a cancer case (family/friends) (data not shown), this can reflect the homogenizing effect of school educational environment and reinforces the potential of this target population for effective cancer prevention education campaigns.

These results are in accordance to recent studies conducted in Portuguese general population [30, 31]. One of the studies refers that breast cancer is the most spontaneously recognized cancer, especially among the younger individuals and women. More than half consider that the information about prevention, risk factors and screening is sufficient. One third of the respondents to that study assume that are certain cancer types that are preventable, but they do not adopt the adequate behaviors towards prevention [30]. Another

study conducted in Portugal also refers that Portuguese population has the perception that breast cancer is the cancer type of cancer with highest incidence but they do not know or did not answered which cancer type has the highest mortality rate (colorectal cancer) [31].

The main goal of health campaigns is to *inform or influence behaviors in large audiences within a specified time period using an organized set of communication activities and featuring an array of mediated messages in multiple channels generally to produce noncommercial benefits to individuals and society* [32]. Considering our results and the above evidences about cancer literacy of the Portuguese population, it urges to evaluate what is the real effect of cancer campaigns that have been promoted trough the different media channels.

Conclusions

In conclusion the current research shows an overall medium/low cancer literacy among adolescents which encloses a wide potential for improvement, namely on colorectal cancer, risk factors and cancer prevention.

The results of this study also showed that knowledge and perceptions about the disease depend on individual context (e.g. gender, school grade) and that the relevance of screenings and prevention behaviors is frequently neglected.

The profiling of our study population provided us the necessary tools to design, target and adapt future campaigns/messages that will help to increase cancer literacy in order to achieve two major goals: i) provide adequate information to increase knowledge about cancer, ii) improve skills and decision-making competences to enable beneficial behavior changes towards cancer prevention.

Our study raises some questions that need to be tackle in future publications, namely in what concerns students' cancer literacy association to their: 1) individual characteristics and behaviors regarding health promotion and disease prevention; 2) socio-economic family status and parents' education; and 3) academic results and school motivation. It also points out future research lines on this topic that should be explored and extended: 1) expand this study to a nationwide scale; 2) characterize adolescents as health information consumers, to better understand the reasons behind these results; and finally 3) establish new strategies and guidelines to effectively increase cancer literacy among this population and others (e.g. western countries), since it is a crucial condition to improve their skills to enable positive behavior change toward cancer prevention.

Finally bearing in mind that most cancer prevention campaigns in the Western World are based on similar strategies, our results suggest that improving cancer prevention education strategies holds enormous potential in terms of reducing cancer burden of future generations from several countries.

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Additional Information

Additional File 1

Questionnaire “Students Knowledge about Cancer” (35 items organized in three sections).

Question	Answer options
Section 1 - Students self-perceptions about cancer (13 items)	
1.	
1.1. Cervical Cancer	
1.2. Breast Cancer	
1.3. Colorectal Cancer	
1.4. Cancer Prevention	
1.5. Risk Factors	
1.6. HPV	
1.7. Pap Smear Test	
1.8. UV Radiation	
1.9. Melanoma	
1.10. Skin Self-exam	
1.11. Mammography	
1.12. Colonoscopy	
1.13. Hereditary Cancer	
Section 2 - Students knowledge about cancer (18 items)	
2. What is the agent responsible for causing cervical cancer?	<ul style="list-style-type: none"> ▪ <i>Helicobacter pylori</i>; ▪ Pseudomonas; ▪ HPV; ▪ HIV; ▪ I don't know. ▪ Always use condom; ▪ Have several sexual partners;
3. Which of the following behaviors increases the risk of infection by HPV?	<ul style="list-style-type: none"> ▪ Sharing needles with infected people; ▪ Using oral contraceptives; ▪ I don't know. ▪ Breast cancer; ▪ Cervical cancer; ▪ Colorectal cancer; ▪ Skin cancer; ▪ I don't know. ▪ Alterations in cervical cells; ▪ Colon polyps; ▪ Atypical moles; ▪ Breast lumps; ▪ I don't know. ▪ Hereditary mutations; ▪ Excessive and/or inadequate sun exposure; ▪ Production of vitamin D in excess; ▪ Extended exposure to radioactivity; ▪ I don't know. ▪ Only men; ▪ Only women; ▪ Mainly men; ▪ Mainly women; ▪ I don't know. ▪ Biopsy; ▪ Mammography; ▪ Endoscopy; ▪ Cytology; ▪ I don't know. ▪ 7h – 10h; ▪ 16h – 18h; ▪ 9h – 11h; ▪ 11h – 17h; ▪ I don't know. ▪ People with fair skin; ▪ People with dark skin; ▪ People with many moles; ▪ All of the options above; ▪ I don't know.
4. Taking a vaccine can prevent what type of the following cancers?	
5. The Pap smear test detects:	
6. What is the main cause for the majority of skin cancer cases?	
7. Breast Cancer is a disease that affects ...	
8. Which of the following is a breast cancer screening test?	
9. What time of day is the most dangerous for sun exposure?	
10. Which of these groups is at risk of developing skin cancer?	

Scale 0 (“I know nothing”) – 10
 (“I know almost everything”)

11. Which of the following cancer types is the most deadly for women worldwide?
 - Breast cancer;
 - Cervical Cancer;
 - Colorectal Cancer;
 - Skin Cancer;
 - I don't know.
 - Decrease alcohol consumption;
 - Decrease the number of sexual partners;
 - Increase calories intake;
 - Decrease the use of antiperspirants;
 - I don't know.
 - Biopsy;
 - Mammography;
 - Colonoscopy;
 - Cytology;
 - I don't know.
 - If you have a low fat and red meat diet;
 - If you has other cases in your family;
 - If you are infected by *Helicobacter pylori*;
 - If you are a female;
 - I don't know.
 - Exercise regularly;
 - Increase calories intake;
 - Eradication of *Helicobacter pylori*;
 - Decrease salt consumption;
 - I don't know.
12. Which of the following measures decreases the risk of breast cancer for a woman?
 - Breast Cancer;
 - Skin Cancer;
 - Colorectal Cancer;
 - Cervical Cancer;
 - I don't know.
 - Basal cell skin cancer;
 - Squamous cell skin cancer;
 - Melanoma;
 - Sarcoma;
 - I don't know.
 - Yes;
 - No.
13. Which of the following is a colorectal cancer screening test?
 - Yes;
 - No.
 - Yes;
 - No.
14. There is an increase of the probability to develop colorectal cancer...
 - Yes;
 - No.
 - Yes;
 - No.
15. Which of the following measures decreases the risk of colorectal cancer?
 - Yes;
 - No.
 - Yes;
 - No.
16. What is the most deadly cancer in Portugal?
 - Yes;
 - No.
 - Yes;
 - No.
17. What is the most deadly type of skin cancer?
 - Yes;
 - No.
 - Yes;
 - No.
18. Do you know about your family history of cancer?
 - Yes;
 - No.
 - Yes;
 - No.
19. If you don't know, have you already try to know?
 - Yes;
 - No.
 - Yes;
 - No.
20. School ID
21. Gender
22. Date of Birth
23. Grade

Section 3 – Students socio-biographic characterization (4 items)

Open-ended question.

- Male;
- Female.

Open-ended question.

- 8th;
- 10th;
- 11th.

Additional File 2

Students' characterization (n=1217).

		N	%
Gender	Male	659	54.2
	Female	554	45.5
	<i>Missing data</i>	4	0.3
Age	13 y	257	21.2
	14 y	94	7.7
	15 y	336	27.7
	16 y	380	31.2
	17 y	127	10.4
	18 y	16	1.3
	19 y	3	0.2
	20 y	4	0.3
	<i>Missing data</i>	1	0.1
School Grade	8 th	378	31.1
	10 th	452	37.1
	11 th	386	31.7
	<i>Missing data</i>	1	0.1
Education level	Middle School	378	31.1
	High School	838	68.8
	<i>Missing data</i>	1	0.1
School region	North	1126	92.5
	Center	91	7.5

The results shown in these table, briefly characterized the students' sample, according to their main socio-biographic characteristics (gender, age, grade and education level) and the school region where schools are located.

Additional File 3

Topics comparison on Perceptions and Knowledge about cancer.

		p-value ^a	p-values ^b				
			CC*	SC*	BC*	CRC*	RF*
Perceptions	Skin Cancer	<0.001	1.000	---	---	---	---
	Breast Cancer		<0.001	<0.001	---	---	---
	Colorectal Cancer		<0.001	<0.001	<0.001	---	---
	Risk Factors		<0.001	<0.001	1.000	<0.001	---
	Prevention		<0.001	<0.001	0.078	<0.001	0.116
Knowledge	Skin Cancer	<0.001	<0.001	---	---	---	---
	Breast Cancer		<0.001	0.011	---	---	---
	Colorectal Cancer		<0.001	<0.001	<0.001	---	---
	Risk Factors		<0.001	<0.001	<0.001	1.000	---
	Prevention		<0.001	<0.001	0.006	<0.001	<0.001

^a Related-Samples Friedman's Two-Way Analysis of Variance by Ranks.

^b Corrected p-values from Pairwise Tests.

* CC-Cervical Cancer; SC-Skin Cancer; BC-Breast Cancer; CRC-Colorectal Cancer; RF-Risk Factors.

Chapter 3

“Cancer – Educate to Prevent’ – High-school teachers, the new promoters of cancer prevention education campaigns”

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Abstract

Cancer is one of the leading causes of death worldwide, and thus represents a priority for national public health programs. Prevention has been assumed as the best strategy to reduce cancer burden, however most cancer prevention programs are implemented by healthcare professionals, which constrain range and educational impacts.

We developed an innovative approach for cancer prevention education focused on high-school biology teachers, considered privileged mediators in the socialization processes. A training program, “Cancer, Educate to Prevent” was applied, so that the teachers were able to independently develop and implement prevention campaigns focused on students and school-related communities. The program encompassed different educational modules, ranging from cancer biology to prevention campaigns design. Fifty-four teachers were empowered to develop and implement their own cancer prevention campaigns in a population up to five thousands students.

The success of the training program was assessed through quantitative evaluation – questionnaires focused on teachers’ cancer knowledge and perceptions, before the intervention (pre-test) and immediately after (post-test). The projects developed and implemented by teachers were also evaluated regarding the intervention design, educational contents and impact on the students’ knowledge about cancer. This study presents and discusses the results concerning the training program “Cancer, Educate to Prevent” and clearly shows a significant increase in teacher’s cancer literacy (knowledge and perceptions) and teachers’ acquired proficiency to develop and deliver cancer prevention campaigns with direct impact on students’ knowledge about cancer.

This pilot study reinforces the potential of high-school teachers and schools as cancer prevention promoters and opens a new perspective for the development and validation of cancer prevention education strategies, based upon focused interventions in restricted targets (students) through non-health professionals (teachers).

Introduction

Cancer is a major worldwide public health problem being the control of cancer incidence and mortality rates a significant challenge to national health systems [1], [2], [3], [4], [5], [6], [7]. Cancer prevention is nowadays assumed as the most effective strategy to address this public health problem, with some authors referring cancer as *the most preventable and the most curable of major chronic life-threatening diseases* [6]. Cancer education programs that raise the awareness for risk factors and promote healthy lifestyles among general audiences are fundamental initiatives in primary prevention [8]. Unfortunately, comprehensive studies designed to identify target groups and/or social environments (family, school, workplace) predisposed to priority interventions are uncommon as well as studies addressing evaluation of educational impacts [9].

The school system is a privileged socialization instance. In fact, studies demonstrate that schools have the capability and the necessary tools to provide a positive impact on students' health [10], [11]. Teachers are *active* social mediators [12] and thus they are key players for cognitive and practical (behavioral) changes. They are the main agents of school socialization and they are invested to perform a triangulated mediation, interacting with the school, the students and the families. A previous study conducted in 1989, at primary and secondary schools of 12 European Union countries demonstrated the potential of the teachers in health education at schools, namely on cancer prevention [13]. More than two decades after that study, experimental research evaluating the feasibility of a cancer prevention education model based upon teachers, both in Portugal and all over Europe, remains to be done.

Regardless of the schools potential to promote Cancer Education programs in local communities, so far this task has been assigned to healthcare professionals from institutions, such as universities, public health schools, medical centers and other cancer related organizations. Most of these interventions are local, uncoordinated and without any follow up on educational impact [10], [14], [15].

As it is known, more than half of all cancer deaths can be attributed to unhealthy behavioral options [16]. Consequently our nuclear argument is that cancer prevention education programs centered on school-based interventions may be more efficiently delivered to larger audiences, and with enhanced impact on long-term behavioral changes. Our hypothesis is that biology teachers can be successfully trained to independently develop and promote relevant cancer prevention education programs in schools. Our research was focused on

evaluating the feasibility of training high school biology teachers educational skills on cancer prevention, so they will be able to develop their own materials and implement impactful cancer prevention campaigns in schools. The program “Cancer, Educate to Prevent” is an innovative approach for cancer prevention education, which trains the teachers to: a) learn the basic principles of cancer biology, epidemiology and prevention; b) select, validate and organize relevant information (e.g. scientific literature databases); plan and implement prevention campaigns at schools. The results obtained clearly showed that perceived and real knowledge about the different cancer topics, significantly increase in trained teachers. Additionally, enrolled teachers have been able to produce and deliver impactful cancer prevention campaigns among their school communities with significantly increase in students’ knowledge about cancer that reached an estimated public of five thousand people. Given that the trained teachers reflect the general profile of Portuguese Biology teachers, this pilot study reinforces the potential of teachers and schools as cancer prevention promoters and opens a new perspective for a nation-wide strategy on cancer prevention education.

Methodology

Training program

During 2012, we carried out a training program “Cancer, Educate to Prevent” for biology teachers, certified by the Portuguese Ministry of Education and Science and promoted by health education specialists from Ipatimup. Sixty-two teachers from schools of the North and Centre of Portugal were voluntary enrolled in this program. Although it is a small sample for theoretical statistical purposes, it is a representative sample for our research goals (indeed, it’s the maximum number of participants the program could deal with, considering all the research process and methodological strategies).

The training program was focused on five of the most incident cancers in Portugal: colorectal, gastric, breast, cervical and skin cancer and encompassed 20 hours of e-learning sessions (on Moodle platform) and 5 hours of classroom sessions at Ipatimup. The program was structured in 5 training modules: Module 1: Introduction (classroom session); Module 2: Basics of Cancer Biology (e-learning sessions with video casts); Module 3: Prevention (e-learning sessions); Module 4: Development of cancer prevention projects to be implemented at schools; and Module 5: Final session, insight into strategies for cancer awareness and prevention (classroom session). This program had 25 hours of effective training, plus the production and implementation of the cancer prevention education projects developed by the teachers’, which on practice has meant that this initiative had a total duration of 4 months.

During the training program, all the participants were continuously evaluated through individual tests performed at the end of every e-learning session. Finally, in the last session teachers were tested about the basic principles of cancer biology and cancer prevention. The extensive evaluation scheme allowed the trainees to optimize the training process according to their own individual characteristics.

Instruments for data collection - characterization and assessment

Apart from direct observation all along the program, we collected the data using four questionnaires: 1) “Trainees characterization”; 2) “Trainees perception and knowledge about cancer”; 3) “Trainees assessment on the training Program”; and 4) “Students knowledge about cancer and socio-biographic characterization” (see questionnaires in supporting information). The first one included 32 items organized in three sections: i) Characteristics of other training programs attended in the last three years (11 items); ii) Information on this specific training program (3 items); and iii) Personal and professional data (18 items). The

second one included 34 items also organized in three sections: i) Trainees perceptions on population cancer knowledge (3 items); ii) Trainees self-perceptions on cancer knowledge (11 items); and iii) Trainees knowledge on cancer (20 items). The items about trainees' self-perception and knowledge about cancer were organized in four main themes: Cancer Biology, Cancer Prevention, Cancer Epidemiology and Scientific literature databases. The third questionnaire included 29 items organized in three sections too: i) Program structure and organization assessment (19 items); ii) Program impact assessment (6 items); and iii) Program accomplishments on trainees' expectations assessment (4 items). The fourth questionnaire included 19 items and was organized in two sections: i) Students knowledge on cancer with 16 items and ii) Students socio-biographic characterization that included 3 items.

Study Design and Data Analysis

This pilot study followed a *quasi-experimental* design, with a pre-test before the intervention and a post-test after its conclusion [17]. At the beginning of the program, in the first classroom session, we applied the questionnaire "Trainees characterization" and the questionnaire "Trainees perception and knowledge about cancer", in a paper format (pre-test). In the last classroom session, we applied again the second questionnaire (post-test). After the end of the program, the questionnaire "Trainees assessment on the training program" was applied online, at the Moodle platform. The questionnaire "Students knowledge about cancer and socio-biographic characterization" was applied in a paper format, both on experimental and on control groups before the implementation of the prevention campaigns designed by teachers (pre-test) and immediately after the intervention (post-test) (see questionnaires in supporting information).

This pilot study was approved (accredited) by two different review boards of Portuguese Ministry of Education and Science: a) The Scientific and Pedagogical Council for Continuous Education and b) The System for Monitoring Schools Surveys. All the participants (teachers and in the case of the students, their parents or tutors) have provided their written informed consent to participate in this study.

Data from surveys were analyzed using IBM® SPSS® Statistics, version 21. The distribution analysis of the variables under consideration revealed that these couldn't be considered normally distributed. Thus, we opted for the use of nonparametric tests (*Related Samples Friedman's Two-Way Analysis of Variance by Ranks*, *Related-Samples Wilcoxon Signed Rank Test* and *Independent-Samples Mann-Whitney U Test*).

Student sampling

A total of 1,648 students spread over 82 classes were directly involved in the projects implemented by the 54 teachers that finished the training program.

We randomly selected - by cluster sampling - 21 of these classes to include in the experimental group (a total of 490 students out of 1,648), according to the following inclusion criteria: classes from public schools attending to the 8th, 10th or 11th grade – in order to ensure a 1 year follow-up (9th and 12th grade students' conclude a study cycle and might move to a different school). Besides, the number of classes selected from each geographic region was defined accordingly to its demographic density.

After defining the experimental group we selected 13 classes (a total of 298 students) to include in the control group. These classes were selected according to the same inclusion criteria defined to the experimental group, from the same regions (specifically from the same districts), with similar social, economic and demographic characteristics in terms of context, which had any kind of participation in this project (any teachers of these schools were involved in the training program).

At the end of the program we had a drop out of 3 classes on the experimental group and 2 classes on the control group, resulting in a sample of 18 classes in the experimental group (385 students) and 11 classes in the control group (236 students).

Results

Teachers

Sample characterization

The questionnaire of “Trainees characterization” showed that of the 62 biology teachers that participated in the training program, 88.7% (55) are females and 87.1% (54) have less than 50 years old (more information on teachers’ personal data, Table S1 in supporting information). Most of them have a stable professional status, since 83.9% (52) have 11 or more years of service and already belong to the school staff. Also, 88.7% (55) of the trainees teach in public schools from North or Center region of Portugal, 74.2% (46) teach between 19 and 22 hours a week and 83.9% (52) perform other activities in school (e.g. management and administration) (more information on teachers’ professional data, Table S2 in supporting information). The trainees were also asked about their involvement in other professional activities, specifically in health related jobs and 95.2% (59) answered that they never worked in this area before (more information on teachers’ training profile, Table S3 in supporting information).

Fifty-six teachers (90.3%) took notice of this training program by e-mail, and the remaining by other colleagues (by word of mouth). When asked about the main reasons why they decided to participate in the program, 82.1% (46) indicated “knowledge acquisition”, 50% (28) mentioned the “prestige of the institution Ipatimup”, and 42.9% (24) indicated “personal motivation”. Knowledge acquisition was also identified by 94.4% (51) of the teachers, as the main reason that motivated them to enroll training programs before 2011/2012 (Figure 3.1).

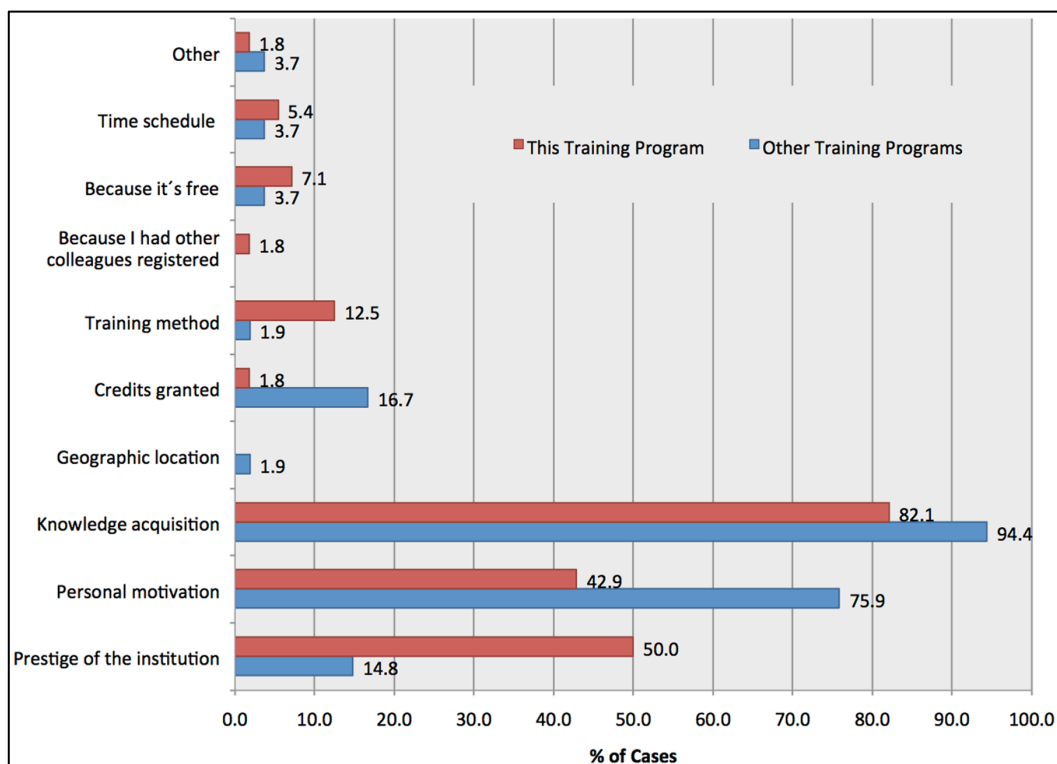


Fig. 3.1 – Reasons why teachers choose the training programs attended before the academic year 2011/2012 and the training program Cancer, Educate to Prevent (n=62).

The main reasons selected by teachers to participate in the training programs before 2011/2012 were: 94.4% (51) knowledge acquisition; 75.9% (41) personal motivation (71%) and 16.7% (9) credits granted.

Personal motivation was pointed out as the second most important reason, by 75.9% (41) of the teachers. Fifty-four (87.1%) out of the 62 teachers that enrolled the training program completed it with success, and 8 (12.9%) of them dropped out during the e-learning sessions and project implementation phase.

Perceptions and knowledge about cancer

Pre-test

The questionnaire “Trainees perception and knowledge about cancer” applied at the beginning of the training program (*pre-test*), showed that the teachers had a perception level of 56.8% on Cancer Biology, 61.8% on Cancer Prevention, 38.8% on Cancer Epidemiology and 36.4% on Scientific Literature Databases (Table 3.1).

Table 3.1 – Pre-test and post-test results on teachers' self-perception and knowledge about cancer (n=56).

		Pre-test		Post-test		Post-test - Pre-test	
		Mean (%)	SD	Mean (%)	SD	Dif. ^c (%)	p-value ^a
Perceptions	Cancer Biology	56.8	18.8	86.3	12.1	29.5	<0.001
	Cancer Prevention	61.8	21.1	92.7	8.8	30.9	<0.001
	Cancer Epidemiology	38.8	21.8	86.3	13.0	47.5	<0.001
	Scientific Literature Databases	36.4	22.8	85.2	13.5	48.8	<0.001
	Global ^b	53.5	17.0	86.8	10.8	33.4	<0.001
Knowledge	Cancer Biology	51.0	18.0	87.7	6.3	36.7	<0.001
	Cancer Prevention	81.7	19.4	98.9	4.5	17.2	<0.001
	Cancer Epidemiology	56.3	23.0	89.3	18.1	33.0	<0.001
	Scientific Literature Databases	43.8	34.5	99.1	6.7	55.4	<0.001
	Global ^b	60.1	12.1	91.9	4.5	31.8	<0.001

^a Pre-test versus Post-test: Related-Samples Wilcoxon Signed Rank Test.

^b Overall weighted mean (according to the number of items in each topic).

^c Difference between the Post-test Mean and the Pre-test Mean (in %).

Comparing the levels of perception on the four topics (based on *Friedman's Two-Way Analysis of Variance by Ranks*) we conclude significant statistical differences among them ($p < 0.001$, Table 3.2).

Table 3.2 – Topics comparison: Perceptions, Knowledge, Pre-test and post-test (n=56).

		Pre-test			Post-test		
		p-value ^a	p-values ^b		p-value ^a	p-values ^b	
			CB*	CP*		CB*	CP*
Perceptions	Cancer Prevention		1.000	---		0.001	---
	Cancer Epidemiology	<0.001	<0.001	<0.001	<0.001	1.000	<0.001
	Scientific Literature Databases		<0.001	<0.001		1.000	<0.001
Knowledge	Cancer Prevention		<0.001	---		<0.001	---
	Cancer Epidemiology	<0.001	0.265	<0.001	<0.001	<0.001	0.069
	Scientific Literature Databases		1.000	<0.001		<0.001	1.000

^a Related Samples Friedman's Two-Way Analysis of Variance by Ranks.

^b Corrected p-values from Pairwise Tests.

* CB – Cancer Biology, CP – Cancer Prevention, CE – Cancer Epidemiology.

The *Pairwise Analysis* allows us to identify which specific topics significantly differ from each other (Table 3.2). According to this analysis, the perception levels on Cancer Biology are significantly higher than the levels on Cancer Epidemiology ($p < 0.001$) and Scientific Literature Databases ($p < 0.001$); and the perception levels on Cancer Prevention are significantly greater than the levels on Cancer Epidemiology ($p < 0.001$) and Scientific Literature Databases ($p < 0.001$).

The assessment on trainees' knowledge revealed levels of 51.0% on Cancer Biology, 81.7% on Cancer Prevention, 56.3% on Cancer Epidemiology and 43.8% on Scientific Literature Databases.

Comparing the levels of knowledge on the four topics we conclude significant statistical differences among them ($p < 0.001$, Table 3.2). According to the *Pairwise Analysis* (Table 3.2), the level of knowledge on Cancer Prevention is significantly higher than the correspondent level on each of the other three topics (all the p -values < 0.001). These differences range from 25.4% to 37.9%.

In Table 3.3 we compare the perception levels to knowledge levels at the beginning of the program. In general, the levels of knowledge are higher than the levels of perception. The topic related to Cancer Biology is the only exception, where perception is above knowledge. Despite this difference is statistically significant ($p = 0.043$), is only 5.8%. The knowledge level on Cancer Prevention is 19.9% above the perception level and on Cancer Epidemiology this difference is 17.5% (both of these differences are statistically significant, with p -values < 0.001). The level of perception on Scientific Literature Databases is 7.3% below the knowledge level and this difference is not statistically significant ($p = 0.168$). On the overall assessment, despite of statistically significant ($p = 0.003$), the difference between knowledge and perception levels is only 6.6%.

Table 3.3 – Teachers' Perception versus Knowledge (n=56).

	Pre-Test		Post-Test	
	Knowledge % - Perception %	p-value ^a	Knowledge % - Perception %	p-value ^a
Cancer Biology	-5.8	0.043	1.4	0.778
Cancer Prevention	19.9	< 0.001	6.3	< 0.001
Cancer Epidemiology	17.5	< 0.001	3.0	0.331
Scientific Literature Databases	7.3	0.168	13.9	< 0.001
Global ^b	6.6	0.003	5.0	0.001

^a Related-Samples Wilcoxon Signed Rank Test.

^b Overall weighted mean (according to the number of items in each topic).

Post-test

The questionnaire "Trainees perception and knowledge about cancer" applied at the end of the training program (*post-test*), showed that the levels of perception were 86.3% on Cancer Biology, 92.7% on Cancer Prevention, 86.3% on Cancer Epidemiology and 85.2% on Scientific Literature Databases (Table 3.1).

Comparing the levels of perception on the four topics, we conclude significant statistical differences among them ($p < 0.001$, Table 3.2). According to the *Pairwise Analysis* (Table 3.2), the perception level on Cancer Prevention is significantly higher than the correspondent level on each of the other three topics (all the p -values ≤ 0.001), although this differences only ranges from 6.4% to 7.5%.

The levels of knowledge were 87.7% on Cancer Biology, 98.9% on Cancer Prevention, 89.3% on Cancer Epidemiology and 99.1% on Scientific Literature Databases (Table 3.1).

Comparing the levels of knowledge on the four topics we conclude significant statistical differences among them ($p < 0.001$, Table 3.2). According to the *Pairwise Analysis* (Table 3.2), the level of knowledge on Cancer Biology is significantly lower than the correspondent level on each of the other three topics (all the p -values < 0.001). These differences range from 1.6% to 11.4%. The level of knowledge on Cancer Epidemiology is significantly lower than the correspondent level on Scientific Literature Databases ($p = 0.036$).

In Table 3.3 we compare the perception levels to knowledge levels at the end of the program. The levels of knowledge are higher than the levels of perception in all topics. These differences are 1.4% on Cancer Biology and 3.0% on Cancer Epidemiology, both with no statistical significance ($p = 0.778$ and $p = 0.331$, respectively). On Cancer Prevention this difference is 6.3% and 13.9% on Scientific Literature Databases, both statistically significant (with p -values < 0.001). The global difference between knowledge and perception is statistically significant ($p = 0.001$), but is only 5.0%.

Pre-test versus Post-test

Comparing the post-test with the pre-test results we can conclude a significant increase on the trainees self-perceptions and knowledge at the end of the training program, in each of the four topics and in the overall assessment (all the p -values < 0.001 , Table 3.1). Cancer Biology increased 29.5% on self-perceptions and 36.7% on knowledge; Cancer Prevention increased 30.9% on self-perceptions and 17.2% on knowledge; Cancer Epidemiology increased 47.5% on self-perceptions and 33.0% on knowledge; and Scientific Literature Databases increased 48.8% on self-perceptions and 55.4% on knowledge. At last, the overall assessment increased 33.3% on self-perception and 31.8% on knowledge. These results are presented in Table 3.1, Figure 3.2 and Figure 3.3.

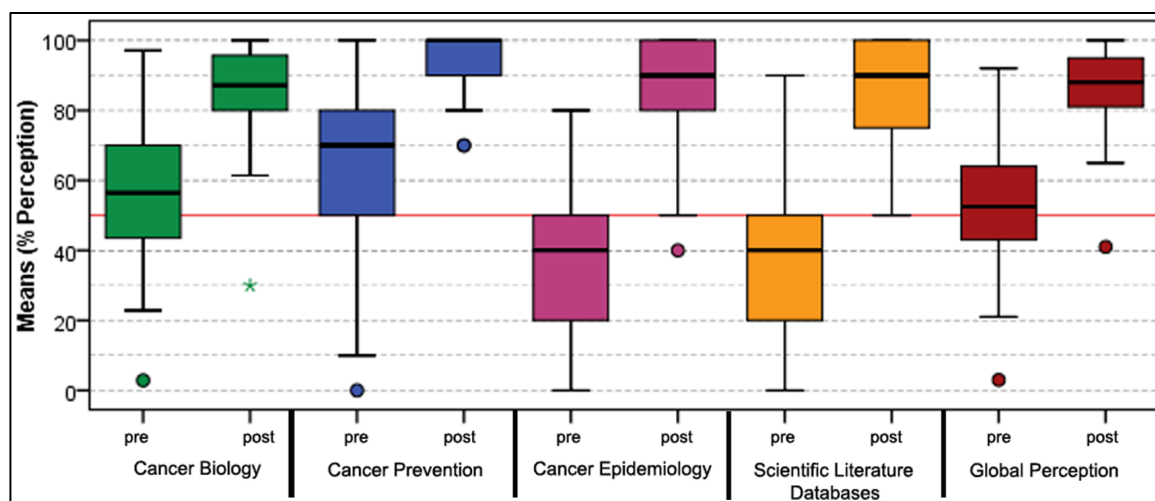


Fig. 3.2 – Teachers' self-perceptions about cancer.

This figure shows the teachers' self-perceptions regarding the pre-test and the post-test. Results are shown in four main subjects (Cancer Biology, Prevention, Epidemiology and Scientific Literature Databases and Global perception).

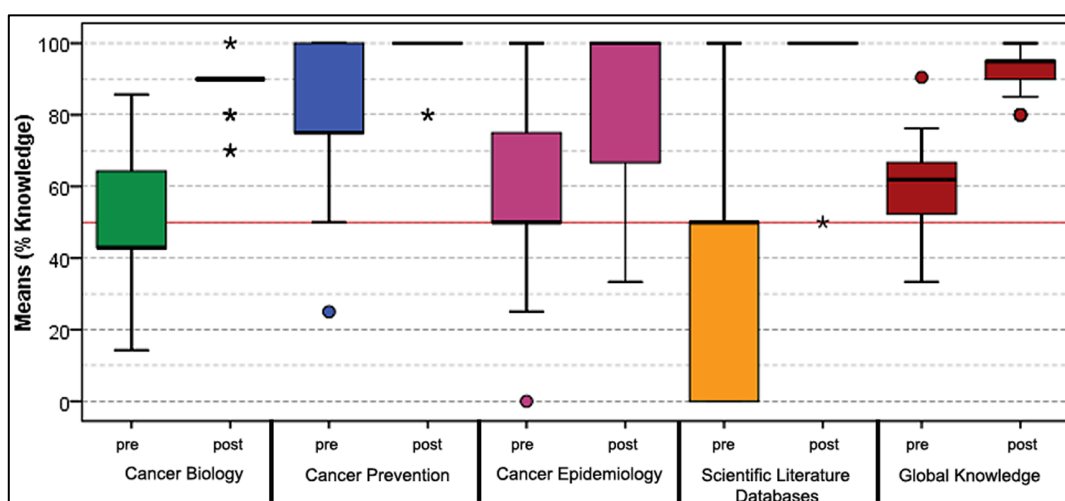


Fig. 3.3 – Teachers' knowledge about cancer.

This figure shows the teachers' knowledge regarding the pre-test and the post-test. Results are shown in four main subjects (Cancer Biology, Prevention, Epidemiology and Scientific Literature Databases and Global perception).

The dropout rate at this training stage was 9.7% (6 teachers out of 62 that started the program).

Cancer prevention education projects developed and implemented by teachers

Ninety six percent (54 out of 56) of the teachers that completed the training program have also achieved the implementation of their own cancer prevention education projects at their schools. Cancer prevention projects were focused on breast, cervical, skin and colorectal cancer.

A total of 1,648 students from 82 middle and high school classes, were directly involved in the projects, 72.2% (39) of the teachers implemented their project with high school students and only 27.8% (15) with middle school students.

Almost all the projects implemented, 88.9% (48) requested the active participation of the students, as the primary target of these campaigns. Students were engaged in several events, from seminars to laboratory and outdoor activities, which provided a greater interaction between teachers and students, a critical point for the success of these actions. In the cancer prevention education projects, 77.8% (42) of the teachers used oral presentations/seminars, 79.6% (43) used printed materials (posters or leaflets), 38.9% (21) used audiovisual contents, and 11.1% (6) lab activities. Moreover, 25.9% (14) of the projects had a contribution or intervention of external healthcare professionals (nurses, medical doctors and pharmacists) while 57.4% (31) implemented innovative approaches such as roleplaying activities, outdoor activities and healthy eating demonstrations. Besides involving directly their students, trained teachers' extended the intervention through the entire schools communities reaching an estimated total of five thousand students. It is also important to emphasize that these cancer prevention projects, due to produced materials and activities, exceed the school context, reaching families and local communities (data not shown).

Training Program Evaluation

The questionnaire "Trainees assessment on the training program", applied at the end of the training was answered by 85.5% (53) of the participants. All the trainees agreed about the coherence of contents presentation while 98.1% (52) agreed about its relevance. In which concerns the adopted methodologies, 92.5% (49) of the trainees agreed that they were appropriate and motivational and all the trainees agreed about the effectiveness of the support provided by the trainers.

In which refers to the adequacy of the training methods, only 7.5% (4) of the individuals considered that the training methodology was not adequate neither stimulating, while 9.4% (5) consider the assessment methods of the training program inadequate. Moreover, 56.6% (30) of the respondents considered the duration of the training program appropriate while 34.0% (18) considered it too short and 9.4% (5) considered it too long.

About the impact of this training program, all the trainees considered it as relevant or very relevant to teachers' personal development and 98.2% (52) considered that it increased their social/civic responsibility. Also 98.2% (52) of the trainees considered it relevant or very relevant to increase knowledge about cancer prevention (both for them and their students). In the answers obtained about behavior changes of the teachers' and their students towards cancer prevention, 88.6% (47) considered the contribution to their own behavior change as relevant or very relevant while, for their students, 92.4% (49) considered it also relevant or very relevant.

Forty-six teachers (87%) claimed that the training program either met or was above their previous expectations with 13% (7) claiming that it was below the expectations. Finally, 96.2% (51) registered that they would recommend this training program to their peers.

Students

Sample characterization

The experimental group has 18 classes from 19 public schools from the North or Center region of Portugal, with a total of 385 students. This group is well balanced by gender, with 54.3 % (209) females and 45.7% (176) males. The mean age is 15.2 years old; 26.8% (103) are attending middle school (8th grade), while the high-schoolers are 34.8% (134) of the 10th grade; and 38.4% (148) of the 11th grade.

The control group has 11 classes from 5 public schools, with a total of 236 students. In this group, 54.7% (129) are males and 45.3% (107) are females. The mean age is 15.1 years old; 27.5% (65) are attending middle school (8th grade), while high-schoolers 47.0% (111) of the 10th grade and 25.4% (60) of the 11th grade.

Knowledge about cancer

Pre-test

The questionnaire "Students knowledge about cancer and socio-biographic characterization" applied before the implementation of the projects (*pre-test*), showed that the cancer knowledge levels in experimental group were 54.1% for Cervical Cancer, 58.3% for Breast Cancer, 32.1% for Colorectal Cancer and 60.3% for Skin Cancer, while for the control group the levels were 40.5% for Cervical Cancer, 52.3%, for Breast Cancer, 20.7% for Colorectal Cancer and 60.6% for Skin Cancer (Table 3.4). The overall knowledge was 43.6% (Table 3.4).

Table 3.4 – Pre-test and post-test results on Students' knowledge about cancer.

	Experimental Group (N=385)						Control Group (N=236)						
	Pre-test		Post-test		Post-test - Pre-test		Pre-test		Post-test		Post-test - Pre-test		
	Mean (%)	SD	Mean (%)	SD	Post-test - Pre-test Diff. ^c (%)	p-value ^a	Mean (%)	SD	Mean (%)	SD	Post-test - Pre-test Diff. ^c (%)	p-value ^a	
Cervical Cancer	54.1	32.0	56.8	32.0	2.7	0.071	40.5	26.0	45.7	28.4	5.2	0.001	0.374
Breast Cancer	58.3	22.2	62.9	21.0	4.6	<0.001	52.3	19.2	55.1	20.5	2.8	0.058	0.343
Colorectal Cancer	32.1	23.5	39.9	28.0	7.8	<0.001	20.7	18.3	22.6	19.3	1.9	0.153	0.012
Skin Cancer	60.3	22.1	66.4	23.6	6.2	<0.001	60.6	23.8	59.9	24.0	-0.7	0.680	0.006
Global ^b	51.3	15.4	56.7	16.5	5.3	<0.001	43.6	13.7	45.9	15.5	2.3	0.006	0.009

^a Intra-group comparison: Pre-test versus Post-test (Related-Samples Wilcoxon Signed Rank Test).

^b Overall weighted mean (according to the number of items in each topic).

^c Difference between the Post-test Mean and the Pre-test Mean (in %).

^d Inter-group comparison: Difference in Experimental Group versus Difference in Control Group (Independent-Samples Mann-Whitney U Test).

Post-test

The questionnaire “Students knowledge about cancer and socio-biographic characterization” applied after the implementation of the projects (*post-test*), showed that the cancer knowledge levels in the experimental group were

56.8% on Cervical Cancer, 62.9% on Breast Cancer, 39.9% on Colorectal Cancer and 66.4% on Skin Cancer. The overall knowledge was 56.7% (Table 3.4).

On the control group, the levels of knowledge were 45.7% on Cervical Cancer, 55.1% on Breast Cancer, 22.6% on Colorectal Cancer and 59.9% on Skin Cancer. The overall knowledge was 45.9% (Table 3.4).

Pre-test versus Post-test

Intra-group Comparison

Comparing the post-test with the pre-test results in the experimental group, we can conclude a significant increase on cancer knowledge in three of the four topics: 4.6% on Breast Cancer, 7.8% on Colorectal Cancer and 6.2% on Skin Cancer (all the p-values <0.001, Table 3.4). The knowledge on Cervical Cancer increased 2.7%, but it wasn't statistically significant (p=0.071, Table 3.4). The overall knowledge increased 5.3% (p-value <0.001, Table 3.4).

On the control group, we can conclude no significant changes in three of the four topics: 2.8% on Breast Cancer (p-value=0.058), 1.9% on Colorectal Cancer (p-value=0.153) and -0.7% on Skin Cancer (p-value=0.680). The knowledge on Cervical Cancer had a significant increase of 5.2% (p-value=0.001, Table 3.4). The overall knowledge increased 2.3% (p-value=0.006, Table 3.4).

Inter-group Comparison

Comparing the difference between the post-test and the pre-test in the experimental group, with the analogous difference in the control group, we can conclude no significant differences in the topics related to the Cervical Cancer (p-value=0.374) and the Breast Cancer (p-value=0.343). On the topics related to the Colorectal Cancer and the Skin Cancer, the knowledge increase in the experimental group is significantly higher than in the control group (p-value=0.012 and p-value=0.006, respectively, Table 3.4). The overall knowledge also increased significantly higher in the experimental group than in the control group (p-value=0.009, Table 3.4).

Discussion

In this pilot study we designed and implemented a training program - “Cancer, educate to prevent” - for high-school teachers and we further evaluated the program impact on the trainees cancer-related knowledge and proficiency to develop impactful prevention campaigns. We worked with Biology teachers because: i) as experts in biology, it is expected they will be more *intrinsically* motivated for cancer prevention than other teachers [18]; ii) some of the contents they teach are related to prevention; iii) most of the times, they are responsible for health education programs at schools; iv) they are often the first person that students contact when they have doubts, fears or worries about health, and thus they actively influence students health behaviors [19].

The sixty-two high school Biology teachers that participated in this pilot study constitute a homogeneous group in which concerns socio-demographic (e.g. gender and age) and career characteristics (e.g. years of service, job situation) (Tables S1 and S2). Teachers are mostly females, younger than 50 years old, teaching in middle and high schools, with a stable job situation, which gives them the opportunity to manage long-term projects (Table S2). Overall the teacher’s characteristics reflect the profile of “Biology Teachers” population published by the Portuguese Ministry of Education and Science, [20]. It is also clear that the participants share the same motivation profile, given the reasons invoked for participation in this program and the training activities of the last three years (Figure 3.1). In fact, these individuals actively seek to keep updated with regard to their teaching practice and their commitments as educational agents, which is perceived by the number of previous courses (training programs) attended. The accreditation of training activities attended serves also as an indicator that these teachers look for initiatives relevant for their careers progression. Interestingly, despite the teachers’ motivation to attend training activities, only one third of them (21) participated in health-related education trainings (Table S3) with only 3.2% (2) being engaged in extra-curricular health-related activities or jobs. These results reflect the reduced offer of training programs in health education namely in cancer prevention education. Additionally, the existing training programs are promoted by private associations and patients groups being mostly delivered by health professionals. These programs do not have a formal accreditation and thus remain out of teacher’s training scope [21], [22], [23].

At the beginning of the training program the pre-test showed that the teachers already had a basic knowledge about cancer. It is also important to notice that the levels for perception and knowledge are always higher for general topics like Cancer Biology and Cancer Prevention

than for more restrict ones like Cancer Epidemiology or Scientific Literature Databases (Table 3.1, Figures 3.2 and 3.3). The level of knowledge is always higher than the level of perception (though not always statistically significant) except for the topic Cancer Biology with perception being higher than knowledge. This result might be explained by the fact that Cancer Biology is included in high schools Biology curriculum [24]. Teachers could be more confident, because they have to teach these contents to their students and they had an academic background in this area. For the topic Cancer Prevention, most of the guidelines are common sense so teachers tend to know about them. The same does not happen for Cancer Epidemiology and Scientific Literature Databases, being the teachers less confident and with lower knowledge for these topics. Assessment of the training impact (post-test) showed that perception and knowledge significantly increased for all the topics, which proves the effectiveness of the methodology. The trainee's perception levels remain below knowledge levels, which might suggest a defensive attitude about the new acquired competences, nonetheless the majority of trainees (96%) were able to conceive and implement cancer prevention campaigns in their schools. Interestingly, some projects involved the entire school, families and local community, which reveal a strong perception of the importance of the social, cultural, economic and environmental contexts for these types of initiatives [25].

The impact of teachers' prevention projects on students' cancer literacy was assessed in a population of 385 students (experimental group), by comparison with a control population of 236 students. The increase of cancer global knowledge was significantly higher in experimental group vs. controls ($p=0.009$) (Table 3.4, inter-group comparison). A detailed analysis of the experimental group (intra-group comparison) showed that students involved in teacher's prevention projects revealed a statistically significant increase in knowledge for Breast, Colorectal and Skin cancers, while there is no significant increase for the Cervical cancer knowledge which might reflect an existing baseline literacy. Cervical cancer and Human Papilloma Virus (HPV) have been, since 2008, the focus of sounding media campaigns promoting HPV vaccination [26], [27], also the Portuguese schools have mandatory Sexual Education programs started before this intervention [28]. Regarding the results obtained for Breast Cancer in the experimental group there is a significant increase in knowledge still lower than that for Colorectal and Skin Cancer, this might be explain by the fact that Breast Cancer is one of the cancers with higher visibility in media education campaigns [29]. The same reasons stated above [26], [27], [28], [29], can also explain the results obtained in the control group (intra-group comparison). A detailed analysis of the Inter-group comparison showed that, there is a significant increase of Colorectal and Skin

cancers knowledge in experimental population vs. controls, while there is no significant difference for Cervical and Breast cancers which might reflect the exposure of students (both experimental and controls) to available existing information on media. To better understand the reasons behind these results it is necessary to expand the study including a characterization of students as health information consumers.

The unique design of this training program, combining theoretical and practical components where teachers have to implement their own projects on the field, clearly contrast with programs from other Portuguese institutions mentioned before [22], [30]. The successful implementation of the prevention campaigns at schools is a relevant indicator about the feasibility of this innovative model of cancer prevention education. It also proves that, with the same basic training program, teachers are capable of independently produce different cancer prevention campaigns with a wide diversity of contents and formats even in demanding conditions (projects were implemented as an extra-curriculum activity, since in Portuguese schools health education is not formal). Furthermore, the impact of the cancer prevention projects promoted by the teachers in schools is undisputable, proving that teachers were capable to transduce the acquire competencies into impactful campaigns with direct effect in students cancer knowledge. Overall, the training program evaluation showed that teachers consider the training very relevant, with the expectations being exceeded, and they would recommend it to colleagues. Comments and suggestions of the trainees summarized in the SWOT Table (Table 3.5) suggest that podcasts, required work, timing and duration of the training should be optimized in future editions.

Table 3.5 – SWOT table.

	Strengths	Weaknesses
Internal origin (Attributes of the system)	<ul style="list-style-type: none"> • b-learning training; • Development of autonomous (and adapted to a specific school community and context) projects to implement at their schools; • Fast and effective support of the trainers; • Target population (Biology Teachers). 	<ul style="list-style-type: none"> • Timing (period in which the training took place); • Being an extra activity of the school curricula despite the existence of mandatory Health Education programs at Portuguese schools; • Extension and technical language of the podcasts used in e-learning sessions; • Amount of work required; • Short period of time for project implementation in schools.
	Opportunities	Threats
External origin (Attributes of the environment)	<ul style="list-style-type: none"> • Development of a communication network for/between trainees and trainers; • More editions of this training program to teachers that didn't had the opportunity to participate, with the possibility of participation of teachers from different backgrounds; • Upgrade this training program for the participants; • Sharing of the materials/strategies developed by the trainees. 	<ul style="list-style-type: none"> • Current socio-economic constrains; • Dissatisfaction of teachers towards the teaching career; • Funding of training programs.

This table was built considering the evaluation of the training program made by the teachers in which concerns to the strengths and weaknesses, opportunities and threats. It describes some aspects that could be improved in further editions (see Weaknesses) and new ideas that can help teachers to reinforce their role in health education (see opportunities). It is also important to maintain the main structure adopted (methodology) for new editions (see Strengths). The threats found are due to a context of a social and economic crisis that is affecting Portugal.

In conclusion the current research, as a proof-of-concept of an alternative model, showed that high school teachers could be trained to efficiently deliver impactful cancer prevention education campaigns. Considering the obtained results, further lines of research should be explored and extended, namely: a) evaluate the long-term impact of the prevention campaigns delivered by teachers in students cancer literacy and behaviors (ongoing follow-up research); b) evaluate the impact of prevention campaigns delivered by teachers in cancer literacy and behaviors of students' families and local communities; c) evaluate if the training model is transposable to teachers with other academic backgrounds (e.g. arts); d) evaluate if the training model is effective for other diseases (e.g. obesity, diabetes); e) evaluate if the model is nationwide scalable.

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Supporting Information

Supporting Questionnaire S1. “Trainees characterization” (32 items organized in three sections)

Question	Answer options
Section 1 - Characteristics of other training programs attended in the last three academic years before 2011/2012 (11 items)	
1. As a teacher, how many training programs have you attended in the last three academic years?	<ul style="list-style-type: none"> ▪ None; ▪ 1; ▪ 2; ▪ 3; ▪ More than 3; ▪ I don't know how many trainings I attended in the last three academic years.
2. How many credits have you assured?	<ul style="list-style-type: none"> ▪ Less than 1; ▪ Between 1 and 1.99; ▪ Between 2 and 2.99; ▪ Between 3 and 3.99; ▪ Between 4 and 4.99; ▪ 5 or more.
3. How much money did you spend with training programs attended?	<ul style="list-style-type: none"> ▪ All free; ▪ < 100 €; ▪ 100 – 200€; ▪ 200 – 300€; ▪ 200 – 300€; ▪ >300 €.
4. How many training programs have you attended over 30km from your residence area?	<ul style="list-style-type: none"> ▪ None; ▪ 1; ▪ 2; ▪ 3; ▪ More than 3.
5. Which were the main reasons why you chosen the training programs attended before 2011/2012? (Select only two options)	<ul style="list-style-type: none"> ▪ Prestige of the institution; ▪ Personal motivation; ▪ Knowledge acquisition; ▪ Geographic location; ▪ Credits granted; ▪ Training method; ▪ Because I had other colleagues registered; ▪ Because it's free; ▪ Time schedule; ▪ Other.

6. What is the nature of the training programs that you attended?
 - Mandatory;
 - Non-mandatory;
 - Some are mandatory and others are non-mandatory.
 - Life and Physical Sciences (Biology/Geology);
 7. What were the main subjects of the trainings programs that you have attended? (You can select more than one option)
 - Educational Sciences;
 - Teaching practice and Didactics;
 - Personal Education and Ethics;
 - Specific training.
 - Universities and associated labs;
 - Public institutions related to the Ministry of Education;
 8. What are the institutions that promoted the training programs that you participated? (You can select more than one option)
 - Other public institutions not related to the Ministry of Education;
 - Other institutions (Non-public).
 9. Did you attend any Health Education training program?
 - Yes;
 - No.
 - 9.1. If you attended, what were the main themes (subjects) focused on Health Education Training Programs? (You can select more than one option)
 - Nutrition and Physical activity;
 - Mental Health and Bullying;
 - Drugs consumption among teenagers;
 - Flu A (H1N1);
 - STD's (Sexually Transmitted Diseases);
 - Sexual Education;
 - Rare Diseases;
 - Oncological Diseases;
 - Child Safety;
 - Other.
 10. Globally, how do you classify the training programs attended before school year 2011/2012 in which concerns to:
 - Quality of the contents;
 - Trainer competence;
 - Relevance of the knowledge acquired to teaching practice;
 - Organization and Functioning;
 - Personal development.
 - Terrible;
 - Very Bad;
 - Bad;
 - Good;
 - Very good;
 - Excellent;
 - No opinion/Don't know.
- Section 2 - Information on this specific training program "Cancer, Educate to Prevent" (3 items)**
11. How did you know about this training program?
 - Directly, through e-mail;
 - Indirectly, through e-mail forward;
 - Indirectly, through other means (poster, conversation with a colleague or a friend).

12. Choose the two main reasons that led you to participate on this training program (Select only two options):
- Prestige of the institution (IPATIMUP);
 - Personal motivation (I dealt with someone close who has been diagnosed with cancer or I was diagnosed with cancer);
 - Knowledge acquisition;
 - Geographic location;
 - Credits granted;
 - Training method (e-learning);
 - Because I had other colleagues registered;
 - Because it's free;
 - Time schedule;
 - Other.
13. What are your expectations toward the training program "Cancer, Educate to Prevent" for:
- Personal development;
 - Increase of your social responsibility;
 - Increase the level of your cancer prevention knowledge;
 - Your personal behavior change towards cancer prevention;
 - Increase the level of the students' cancer knowledge;
 - Students' behavior change towards cancer prevention.
 - Very low;
 - Low;
 - High;
 - Very High.
 - No opinion/Don't know.

Section 3 - Personal and professional data (18 items)

14. Gender
- Male;
 - Female.
15. Age
- Open-ended question.
16. Marital Status
- Single;
 - Married/Civil Partnership;
 - Divorced/Separated;
 - Widower.
17. Zip Code of your address
- Open-ended question.
18. Education (highest qualification obtained)
- Bachelor;
 - Master;
 - Doctoral.
19. If you have an MsC or a PhD degree, please specify the name of the degree and of the institution.
- Master:
- 19.1. Name of the Institution:
- Open-ended question.
- PhD:
- 19.2. Name of the Institution:
- Open-ended question.
20. How many schools do you work in this academic year?
- 1;
 - 2;
 - 3.
21. Please indicate the zip code of your school(s) address and the number of hours per week that you work in each school.
- Open ended-question.
22. What is your current employment status?
- Term-contract;
 - School staff.

- | | | |
|-------|--|---|
| 23. | How many years of service do you have (until 31 august of 2011)? | Open-ended question. |
| 24. | Do you perform other activities besides teaching at your school? | <ul style="list-style-type: none"> ▪ Yes; ▪ No. |
| 24.1. | If your answer is Yes, what type of activities do you perform? (You can select more than one option) | <ul style="list-style-type: none"> ▪ Administration/School board /School management; ▪ Pedagogical activities (position); ▪ Projects management. |
| 25. | Please indicate the education level where do you teach. (You can select more than one option) | <ul style="list-style-type: none"> ▪ Middle school classes; ▪ High school classes; ▪ Vocational educational classes. |
| 26. | Please indicate the number of classes per grade where do you teach: | Open-ended question. |
| 27. | Besides teaching, have you ever practiced some professional activity in health area? | <ul style="list-style-type: none"> ▪ Yes; ▪ No. |
| 27.1. | If your answer is Yes, Do you still perform this activity with the teaching activity? | <ul style="list-style-type: none"> ▪ Yes; ▪ No. |
| 28 | If you want, you can leave your comment using the blank space available on this page. | Open-ended question. |

Questionnaire S2. “Trainees perception and knowledge about cancer” (34 items organized in three sections)

Question		Answer options
Section 1 – Trainees perceptions on population cancer knowledge (3 items)		
1.		Scale:
1.1.	Population in general	<ul style="list-style-type: none"> ▪ No opinion/Don't know (0)
1.2.	Peers	<ul style="list-style-type: none"> ▪ Terrible (1); ▪ Very Bad (2); ▪ Bad (3); ▪ Good (4); ▪ Very good (5); ▪ Excellent (6);
1.3.	Students	
Section 2 - Trainees self-perceptions on cancer knowledge (11 items)		
2.	For you what is the meaning of the word cancer?	Open-ended question.
3.		
3.1.	Oncogene	
3.2.	Tumor Suppressor Gene	
3.3.	Cell Proliferation	
3.4.	Angiogenesis	
3.5.	Apoptosis	Scale 1(“ Totally unknown”) -10 (“Totally know”)
3.6.	Cell-cell and Cell-matrix adhesion	
3.7.	Invasion and Metastization	
3.8.	Cancer Prevention	
3.9.	Scientific Literature Databases	
3.10.	Cancer Epidemiology	
Section 3 - Trainees knowledge on cancer (20 items)		
4.	Which of the following expressions is a synonym for the word tumor?	<ul style="list-style-type: none"> ▪ Hypertrophy; ▪ Hyperplasia; ▪ Tumor; ▪ Metaplasia. ▪ Viral and bacterial infections; ▪ Excessive consumption of coffee; ▪ Sharing infected needles; ▪ Diet rich in leguminous/ vegetables. ▪ The most frequent cancers have hereditary origin; ▪ Cancer is a genetic disease; ▪ Cancer does not occur in tissues with reduced regenerative rates; ▪ Cancer occurs only in tissues with high regenerative rates.
5.	Which of the following options is a possible cause for cancer:	
6.	Select the right option:	

7. Any gene that encodes a protein whose gain function increases the risk of transformation of a normal cell into a neoplastic cell is called:
 - Proto-oncogene;
 - Pseudo-gene;
 - Oncogene;
 - Tumor Suppressor Gene.
8. Any gene that encodes a protein whose lost it function increases the risk of transformation of a normal cell into a neoplastic cell is called:
 - Proto-oncogene;
 - Pseudo-gene;
 - Oncogene;
 - Tumor Suppressor Gene.
9. Which of the following environmental factors is associated to cancer?
 - Infrared radiation;
 - UV radiation;
 - Sunscreen lotion;
 - Use of antiperspirants.
10. Angiogenesis is...
 - A process of growth of pre-existing blood vessels;
 - The development of new blood vessels from pre-existing blood vessels;
 - The process of substitution of pre-existing blood vessels by new ones;
 - The development of new blood vessels from pre-existing lymphatic vessels.
11. Identify the difference between apoptosis and necrosis:
 - Necrosis is a reversible process whereas the apoptosis is irreversible;
 - Necrosis is a process that occurs independently in each cell, whereas on apoptosis it occurs in groups of surrounding cells;
 - Apoptosis is a process that occurs independently in each cell, whereas on necrosis it occurs in groups of surrounding cells;
 - Necrosis is an irreversible process whereas the apoptosis is reversible.
12. The process by which tumor cells permeate other tissues is called:
 - Invasion;
 - Intravasion;
 - Metastization;
 - Proliferation.
13. Which of the following sentences corresponds to the definition of a risk factor?
 - Factors that decrease the probability of a person to develop cancer;
 - Factors that increase the probability of a person to die from cancer;
 - Factors that increase the probability of a person to develop cancer;
 - Factors that decrease the probability of a person to die from cancer.

- | | | |
|-----|---|---|
| 14. | Every measures with the objective to decrease the probability of develop a cancer are called: | <ul style="list-style-type: none"> ▪ Primary treatment; ▪ Secondary prevention; ▪ Primary prevention; ▪ Secondary prevention. |
| 15. | Which is the section of a scientific article where we can find simultaneously the following information: resume of the work, main methodologies used and main results obtained? | <ul style="list-style-type: none"> ▪ Introduction; ▪ Conclusion; ▪ Abstract; ▪ Results. |
| 16. | “Globocan” is a scientific literature database of... | <ul style="list-style-type: none"> ▪ Bibliographic data; ▪ Pharmacological data; ▪ Diseases and clinical cases; ▪ Epidemiological data. |
| 17. | The annual death rate from cancer in a country is the number of... | <ul style="list-style-type: none"> ▪ Deaths per year; ▪ New cases per year; ▪ Deaths per year divided by the total population of the country; ▪ New cases per year divided by the total population of the country. |
| 18. | The annual prevalence of cancer in a population refers to the total number of... | <ul style="list-style-type: none"> ▪ Cases diagnosed until the moment in that population; ▪ Diagnosed patients who died after a year; ▪ Cases diagnosed multiplied by the the total number of deaths that occurred after one year; ▪ Diagnosed persons who are alive after one year. |
| 19. | Please select from the following myths about cancer which one have support from scientific data: | <ul style="list-style-type: none"> ▪ Contagious; ▪ Exclusive of the human being; ▪ It is a recent disease (XX century); ▪ The number of cases (frequency) is increasing. |
| 20. | Secondary prevention corresponds to the set of measures that have as objective: | <ul style="list-style-type: none"> ▪ Cure cancer; ▪ Avoid metastazition; ▪ Avoid the cancer; ▪ Early detection of cancer. |
| 21. | Select the incorrect option: | <ul style="list-style-type: none"> ▪ The metastastization process involves cancer cells that are carried in blood or lymph vessels; ▪ A metastasis can be defined as a neoplastic dissemination; ▪ The metastasis only occurs in the organs of the circulatory and digestive systems; ▪ In the process of metastasis neoplastic cells invade other tissues. |

22. What is the difference between a benign tumor and malignant neoplasm?
- A benign tumor is associated with minor cancers, while malignant tumors are associated with more severe cancers;
 - A malignant neoplasm is incurable while a benign tumor is curable;
 - A malignant tumor can invade other tissues whereas benign tumors can not invade;
 - A malignant neoplasm is unable to detect clinically unlike a benign tumor.
23. Identify a typical characteristic of cancer cells:
- Sensitivity to growth inhibitory signals;
 - Capacity to induce angiogenesis;
 - Incapacity to proliferate;
 - Sensitivity to apoptosis.

Questionnaire S3. “Trainees assessment on the training program” (29 items organized in three sections)

Question		Answer options
Section 1 – Program structure and organization assessment (19 items)		
1.	The objectives of the training program have been achieved.	
2.	The contents approached in the training program were relevant.	
3.	The contents were presented in a coherent and structured way.	<ul style="list-style-type: none"> ▪ Strongly Disagree; ▪ Moderately Disagree;
4.	The training methods used were appropriate.	<ul style="list-style-type: none"> ▪ Disagree;
5.	The methodologies used built a way of motivation for the trainees.	<ul style="list-style-type: none"> ▪ Agree; ▪ Moderately Agree;
6.	The support provided by the trainers during the training program was effective.	<ul style="list-style-type: none"> ▪ Strongly Agree.
7.	The assessment methods were appropriate and fair.	
8.	The amount of work required was appropriated.	
9.	In terms of time, the duration of the training program it was...	<ul style="list-style-type: none"> ▪ Too short; ▪ Adequate; ▪ Too long.
10.	The number of ... sessions was...	
10.1.	online sessions	<ul style="list-style-type: none"> ▪ Few;
10.2.	classroom sessions	<ul style="list-style-type: none"> ▪ Appropriate; ▪ Too much.
11.		
11.1.	The theoretical component was...	<ul style="list-style-type: none"> ▪ Insufficient; ▪ Adequate;
11.2.	The practical component was...	<ul style="list-style-type: none"> ▪ Excessive. ▪ Extremely Bad; ▪ Very Bad;
12.	The use of the Moodle platform was...	<ul style="list-style-type: none"> ▪ Bad; ▪ Good; ▪ Very good; ▪ Excellent.
13.	Overall assessment of:	
13.1.	e-learning sessions (...)	
13.1.1.	Podcasts.	<ul style="list-style-type: none"> ▪ Extremely Bad; ▪ Very Bad;
13.1.2.	Prezi presentations.	<ul style="list-style-type: none"> ▪ Bad; ▪ Good;
13.2.	Classroom sessions.	<ul style="list-style-type: none"> ▪ Very good; ▪ Excellent.

14. Globally, you positively evaluate the...

14.1. Performance of trainers in classroom sessions.

- Strongly Disagree;
- Moderately Disagree;
- Disagree;
- Agree;
- Moderately Agree;
- Strongly Agree.

14.2. Performance of the speakers in podcasts.

Section 2 - Program impact assessment (6 items)

15.1. Personal development.

15.2. Increase of your social responsibility.

15.3. Increase the level of your cancer prevention knowledge.

15.4. Your personal behavior change towards cancer prevention.

15.5. Increase the level of the students' cancer knowledge.

15.6. Students' behavior change towards cancer prevention.

- Irrelevant;
- Somewhat Relevant;
- Relevant;
- Very Relevant.

Section 3 - Program accomplishments on trainees' expectations assessment (4 items)

16. Would you recommend this training program to a colleague?

17. Regarding your expectations on this this training program...

18. Did you give up on this training program before ending?

18.1. If your answer is yes to the previous question, please explain briefly the reasons?

- Yes;
- No.
- was below your expectations;
- met your expectations;
- was above your expectations.
- Yes;
- No.

Open-ended question.

Questionnaire S4. “Students knowledge about cancer and socio-biographic characterization”
(19 items organized in two sections)

Question		Answer options
Section 1 - Students knowledge about cancer (16 items)		
1.	What is the agent responsible for causes cervical cancer?	<ul style="list-style-type: none"> ▪ <i>Helicobacter pylori</i>; ▪ Pseudomonas; ▪ HPV; ▪ HIV; ▪ I don't know. ▪ Always use condom;
2.	Which of the following behaviors increases the risk of infection by HPV?	<ul style="list-style-type: none"> ▪ Have several sexual partners; ▪ Sharing needles with infected people; ▪ Using oral contraceptives; ▪ I don't know.
3.	Taking a vaccine can prevent what type of the following cancers?	<ul style="list-style-type: none"> ▪ Breast cancer; ▪ Cervical cancer; ▪ Colorectal cancer; ▪ Skin cancer; ▪ I don't know.
4.	The Pap smear test detects:	<ul style="list-style-type: none"> ▪ Alterations in cervical cells; ▪ Colon polyps; ▪ Atypical moles; ▪ Breast lumps; ▪ I don't know.
5.	What is the main cause of the majority of skin cancer cases?	<ul style="list-style-type: none"> ▪ Hereditary mutations; ▪ Excessive and/or inadequate sun exposure; ▪ Production of vitamin D in excess; ▪ Extended exposure to radioactivity; ▪ I don't know.
6.	Breast Cancer is a disease that affects ...	<ul style="list-style-type: none"> ▪ Only men; ▪ Only women; ▪ Mainly men; ▪ Mainly women; ▪ I don't know.
7.	Which of the following is a breast cancer screening test?	<ul style="list-style-type: none"> ▪ Biopsy; ▪ Mammography; ▪ Endoscopy; ▪ Cytology; ▪ I don't know.
8.	What time of day is the most dangerous for sun exposure?	<ul style="list-style-type: none"> ▪ 7h – 10h; ▪ 16h – 18h; ▪ 9h – 11h; ▪ 11h – 17h; ▪ I don't know.
9.	Which of these groups have a major risk of developing skin cancer?	<ul style="list-style-type: none"> ▪ People with fair skin; ▪ People with dark skin; ▪ People with many moles; ▪ All of the options above; ▪ I don't know.
10.	Which of the following cancer types is the most deadly for women worldwide?	<ul style="list-style-type: none"> ▪ Breast cancer; ▪ Cervical Cancer; ▪ Colorectal Cancer; ▪ Skin Cancer; ▪ I don't know.
11.	Which of the following measures decreases the risk of breast cancer for a woman?	<ul style="list-style-type: none"> ▪ Decrease alcohol consumption; ▪ Decrease the number of sexual partners; ▪ Increase calories intake; ▪ Decrease the use of antiperspirants; ▪ I don't know.
12.	Which of the following is a colorectal cancer screening test?	<ul style="list-style-type: none"> ▪ Biopsy; ▪ Mammography; ▪ Colonoscopy; ▪ Cytology; ▪ I don't know.

13. There is an increase of the probability to develop colorectal cancer...
- If you have a low fat and red meat diet;
 - If you has other cases in your family;
 - If you are infected by *Helicobacter pylori*;
 - If you are a female;
 - I don't know.
14. Which of the following measures decreases the risk of colorectal cancer?
- Exercise regularly;
 - Increase calories intake;
 - Eradication of *Helicobacter pylori*;
 - Decrease salt consumption;
 - I don't know.
15. What is the most deadly cancer in Portugal?
- Breast Cancer;
 - Skin Cancer;
 - Colorectal Cancer;
 - Cervical Cancer;
 - I don't know.
16. What is the most deadly type of skin cancer?
- Basal cell skin cancer;
 - Squamous cell skin cancer;
 - Melanoma;
 - Sarcoma;
 - I don't know.

Section 2 – Students socio-biographic characterization (3 items)

17. Gender
- Male;
 - Female.
18. Age
- Open-ended question.
19. Grade
- 8th.
 - 10th.
 - 11th.

Table S1 – Socio-demographic characteristics of the teachers' sample (n=62).

Category	Subcategory	Result (%)
Gender	Male	7 (11.3)
	Female	55 (88.7)
Age	<30 y	4 (6.5)
	30-39 y	16 (25.8)
	40-49 y	34 (54.8)
	≥50 y	8 (12.9)
Education (highest qualification obtained)	Bachelor	50 (80.6)
	Master/Doctoral	12 (19.4)

The results shown in this table refers to the main socio-demographic characteristics: gender, age and education of the 62 teachers that were selected to participate in the training program "Cancer, Educate to Prevent".

Table S2 – Teachers career (n=62).

Category	Subcategory	Result (%)
Years of service	1-10 y	10 (16.1)
	11-19 y	28 (45.2)
	≥20 y	24 (38.7)
Employment status/Working status	Term-contract	10 (16.1)
	School staff	52 (83.9)
Number of schools where teachers work	1	57 (91.9)
	2	4 (6.5)
	Missing data	1 (1.6)
Sector of schools (number of teachers that work in a...)	Public school	55 (88.7)
	Private	3 (4.8)
	Public and Private	1 (1.6)
	Missing data	3 (4.8)
School-time (Hours/Week)	≤13 h	4 (6.5)
	14-19 h	7 (11.3)
	≥20 h	46 (74.2)
	Missing data	5 (8.1)
Performs other activities besides teaching at school	Yes	52 (83.9)
	No	10 (16.1)

Main characteristics of career of the 62 teachers that were selected to participate in the training program, regarding the academic year 2011/2012.

Table S3 – Characteristics of the Training Programs attended by teachers in the last three academic years, before 2011/2012 (n=62).

Category	Subcategory	Result (%)
Number of training programs attended	None	3 (4.8)
	1	3 (4.8)
	2	8 (12.9)
	3	17 (27.4)
	>3	31 (50)
Number of credits granted	<1	1 (1.6)
	1 - 1,99	3 (4.8)
	2 - 2,99	15 (24.2)
	3 - 3,99	20 (32.3)
	4 - 4,99	7 (11.3)
	≥ 5	13 (21)
	Not attended any training program	3 (4.8)
Expenses with training programs	All free	18 (29)
	< 100 €	9 (14.5)
	100 – 200€	20 (32.3)
	200 – 300€	4 (6.5)
	> 300€	8 (12.9)
	Not attended any training program	3 (4.8)
Number of training programs over 30km from the residence area	None	28 (45.2)
	1	18 (29)
	2	4 (6.5)
	3	3 (4.8)
	> 3	6 (9.7)
	Not attended any training program	3 (4.8)
Nature of the training programs	All mandatory	1 (1.6)
	All non-mandatory	26 (41.9)
	Some are mandatory and others are non-mandatory	32 (51.6)
	Not attended any training program	3 (4.8)
Training program subject	Life and Physical Sciences (Biology/Geology)	54 (87.1)
	Educational Sciences	27 (43.5)
	Teaching practice and Didactics	25 (40.3)
	Personal Education and Ethics	8 (12.9)
	Specific trainings	15 (24.2)
	Not attended any training program	3 (4.8)
Attended Health Education training programs	Yes	21 (33.9)
	No	41 (66.1)
	Not attended any training program	3 (4.8)

Institutions that promote training for teachers	Universities and associated labs	30 (48.4)
	Public institutions related to the Ministry of Education	49 (79)
	Other public institutions not related to the Ministry of Education	5 (8.1)
	Other institutions (Non-public)	24 (38.7)
	Not attended any training program	3 (4.8)

The items "Training program subject" and "Institutions that promote training for teachers" derived from a multiple-choice question. Teachers were allowed to select more than one option.

As we can see above, 77.4% (48) of teachers had attended three or more training programs and 64.6% (40) of them granted 3 or more credits. The most frequent, 32.3% (20) amount spent varies between € 100 and € 200 while 29% selected only free training program (18). Geographic location of the programs does not seem a determining factor for participation in training activities since half of the teachers attended programs more than 30km of their residential area. Also, most teachers, 51.6% (32) participated either in training programs that are mandatory and non-mandatory for their career. 87.1% (54) Life and Physical Sciences (Biology and Geology) is the area where trainees participated in more training programs with 87.1% (54), followed by the training programs in Educational Sciences, with 43.5% (27). Part of the trainees, 33.9% (21) also refers that have participated in specific training activities about Health Education especially on sexual education and sexually transmitted infections. These training programs are essential to keep teachers up to date about technical subjects. Institutions that promote the training are also an important issue with 79% (49) of the teachers choosing the institutions related to the Ministry of Education and Science and 48.4% (30) also select universities or associated labs to attend this kind of programs.

General Conclusions

Schools are the core and the right environment for social change. The research conducted for this dissertation emphasizes the relations between science and culture, and the potential that schools have on socialization, then on health, especially in cancer prevention education. Teachers are privileged mediators to promote new values of cancer education due to the direct involvement with the students, and the “insider” perspective of school environment.

The training program “Cancer, Educate to Prevent” was designed and implemented with a group of Portuguese teachers. They were able to design and adapt their interventions to their local context, which can effectively contribute to increase the potential spread effect. Through teachers this program reached the students and spread to families, addressing the problem of cancer prevention on a social context.

Regarding the implementation of the training program - “Cancer, Educate to Prevent” - we evaluated the program impact on the trainees cancer-related knowledge and proficiency to develop impactful prevention campaigns.

The multidisciplinary team involved in this research used a comprehensive methodological strategy that allowed the assessment, evaluation and monitorization of the entire process in order to determine its real impact. At the beginning of the training program the pre-test showed that the teachers already had a basic knowledge about cancer. Besides that, by the end of the training, the majority of trainees were able to conceive and implement cancer prevention campaigns in their schools and further increase their own knowledge about cancer and prevention.

The impact of teachers’ prevention projects on students’ cancer literacy was also assessed and showed that students increased knowledge and perceptions, regarding four types of cancer (cervical, breast, skin and colorectal cancer), after the implementation of the cancer prevention education projects.

The successful implementation of the prevention campaigns at schools is a relevant indicator about the feasibility of this innovative model of cancer prevention education. It also proves that, with the same basic training program, teachers are capable of independently produce different cancer prevention campaigns with a wide diversity of contents and formats even in demanding conditions (projects were implemented as an extra-curriculum activity and without a dedicated budget, since in Portuguese schools health education is not formal). Considering the obtained results, further lines of research should also be explored and extended, namely: a) evaluate the long-term impact of the prevention campaigns delivered by teachers in students cancer literacy and behaviors (ongoing follow-up research); b) evaluate the impact of prevention campaigns delivered by teachers in cancer literacy and behaviors of students’ families and local communities; c) evaluate if the training model is

transposable to teachers with other academic backgrounds (e.g. arts); d) evaluate if the training model is effective for other diseases (e.g. obesity, diabetes); e) evaluate if the model is nationwide scalable; f) if the model is transposable to other countries, i.e. other social and cultural contexts regarding the necessary adaptations.

Furthermore, for impact evaluation purposes, this study, before prevention projects implementation, also assessed students' cancer literacy, considering both perceptions and knowledge. This allowed us to know the current reality resultant from traditional prevention campaigns in Portugal and to draw the students' cancer literacy profile.

Students' perceptions and knowledge were compared on the same four types of cancer (cervical, breast, skin and colorectal cancer), and revealed that colorectal cancer is the topic with the lowest results both on perceptions and knowledge. On the other hand, breast cancer is the topic with higher positive results, both for perceptions and knowledge, being the knowledge average slightly higher than the perceptions average.

Concerning cervical cancer, students have significantly higher levels of knowledge than perceptions nevertheless both averages are below 50%. Considering the skin cancer topic, students' perceptions and knowledge are significantly different, with the perceptions average below 50% and knowledge above that value.

Students' knowledge and perceptions on Risk Factors and Prevention, together with the low levels of overall cancer literacy, are probably the results that stand out in our study. In these two topics, students have average perceptions above 50% and significantly lower levels on average knowledge (below 50%). In addition, the levels on risk factors are significantly lower than those on prevention. These findings suggest that students do not actually know as much as they believe to know about cancer prevention and risk factors. This false perception of knowledge may result from the idea that information related to these topics is just common sense.

In sum, the idea that health campaigns should be tailored and targeted is a reality evidenced in this study. Each school (the privileged environment for social change) is a particular context, so prevention programs must be adapted to its specific characteristics. Also the characteristics of the actors and at the same time the targets of these campaigns must be included in order to understand and drive structural changes in practices as well as in attitudes and behaviors towards cancer prevention as a community goal. Considering the above evidences about cancer literacy of the students, it urges to evaluate what is the real effect of cancer campaigns that have been promoted through the different media channels which points out future research lines on this topic that should be explored and extended: a) characterize adolescents as health information consumers, to better understand the reasons

behind these results; and b) establish new strategies and guidelines to effectively increase cancer literacy among this population and others (e.g. western countries), since it is a crucial condition to improve their skills to enable positive behavior change towards cancer prevention.

In conclusion, the current research is a proof-of-concept of a cancer communication alternative model, based on early, in-depth interventions, tailored and target for specific populations. It clearly showed that high school teachers can be trained to efficiently deliver impactful cancer prevention education campaigns and that younger generations enclose a vast potential for improvement of current medium/low levels of cancer literacy.

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